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AUTHORITY

US Army Edgewood Arsenal ltr, 25 Sep 1968

(MDR No: 103) "WP Casualties at Edgewood Arsenal"

AD — 824420

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WAR DEPARTMENT
OFFICE OF THE CHIEF, CHEMICAL CORPS
WASHINGTON 25, D. C.

CMLEM-52

31 March 1947

Copy No.

MEDICAL DIVISION REPORT NO 103. WP CASUALTIES AT EDGEWOOD ARSENAL MARYLAND, 1945

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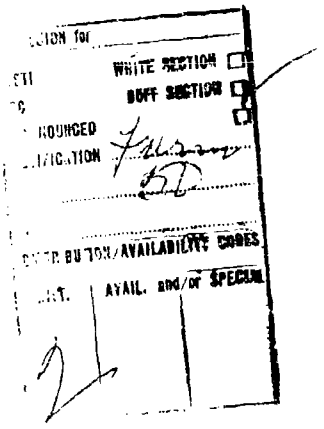

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Medical Division Report No. 103, WP Casualties at Edgewood Arsenal, Maryland, 1945

ABSTRACT

OBJECT.

The present investigation was undertaken to evaluate the WP burn in a series of human patients received from WP loading plant accidents at Edgewood Arsenal, Maryland.

RESULTS.

1. A report is presented on twenty-seven casualties with WP burns and four casualties with respiratory tract injury due to inhalation of WP smoke, resulting from four accidents in plants processing WP munitions at Edgewood Arsenal, Maryland.

2. Nine patients were dead on arrival at the station hospital as a result of third degree burns of 90% or more of the body surface in each case. Eighteen patients with WP burns were admitted to the hospital. Three of these patients with third degree burns of 35% or more of the body surface died within nineteen hours after admission to the hospital. The remaining fifteen patients survived. Four of these had third degree burns of 8-19% of the body surface, in addition to second degree burns. Eleven of the patients had burns of 5% or less area third degree.

3. Four patients sustained laryngitis and tracheobronchitis from inhalation of highly concentrated WP smoke in a small room. Two of these patients had residual hoarseness eight months following injury.

4. Detailed data on blood and urine chemistry, hematology and bacteriology of wounds are presented on six of the severely burned patients.

5. Two patients with 8-15% third degree burns developed massive hemolytic reactions of unknown etiology about twenty-four hours after injury, lasting about seventy-two hours. Both patients received intravenously one-sixth molar sodium lactate to maintain alkalinity of the urine, as well as multiple transfusions. Both patients survived with no demonstrable renal damage.

6. There was no evidence of systemic injury due to absorption of unburned WP.

7. The clinical course and response of the burned areas to applicat' of skin grafts did not appear in any way different from that of the deep third degree thermal burn.

CONCLUSIONS.

1. First aid treatment with 5% copper sulfate solution followed by careful debridement of the burned area is essential in order that unburned WP may be removed.

2. Any lacerated wounds should be carefully debrided to remove possible deeply embedded particles of unburned WP.

3. Aside from the above first aid measures, the treatment of the WP burn in the human being is the same as that of any thermal burn of similar severity.

RECOMMENDATIONS.

None.

Medical Division Report No. 103, WP Casualties at Edgewood Arsenal, Maryland, 1945.

I. INTRODUCTION.

A. Object.

The present investigation was undertaken to evaluate the WP burn in a series of human patients received from WP loading plant accidents at Edgewood Arsenal, Maryland.

B. Authority.

Authorized by the Chief, Chemical Corps, under Project D 8.1, Prevention and Treatment of Chemical Casualties, Cml C Research and Development Program for FY 1944-46.

II. HISTORICAL AND THEORETICAL.

In the WP burn there is a question as to whether unburned WP was absorbed through extensive surface burns in quantities sufficient to produce systemic damage.

The rate of healing of WP burns and the ability of the tissue bed to receive skin grafts as compared with thermal burns has also been questioned.

The series of accident cases reported here permitted study of these questions in human beings.

III. WP BURN CASUALTIES.

A. Source of Casualties.

Between 17 May 1945 and 21 July 1945, there were four accidents in plants handling WP munitions at this station. As a result of these accidents there was a total of 27 casualties due to burns, 9 people being dead on arrival at the station hospital and 18 requiring hospitalization for burns of varying severity.

1. The first accident occurred on 17 May 1945 when a rifle grenade, charged WP, exploded during packing. One person received 10% (5% third degree) burns. A second person received a 20% burn (12% third degree), and was severely injured.

2. The most serious accident occurred on 25 May 1945 in Bldg. 509, where there was an assembly line for igniters, explosive type, incendiary gasoline tank (WP)M 13. Approximately sixty laborers, mostly women, were working in one large room. The assembly line was set up in the center of this room. On this line WP-filled grenade bodies were fitted with adapters, sealed with tar and painted, and C 8 R1 bursters were inserted using an air vise. Apparently the initial explosion occurred in the air vise where adapters were screwed to the filled grenade bodies. The WP flash from the functioning igniter spread flaming particles, caused simultaneous functioning of grenade bodies containing exposed C 8 R1

bursters and a stockpile of unassembled C 8 R1 bursters awaiting insertion into grenades. Eight women grouped around the air vise were burned to death within one or two minutes. One woman standing in front of a tar pot was killed immediately when the molten tar was spilled. Twelve patients were hospitalized with burns, and two of these died within the first nineteen hours following the accident. Three patients were admitted with lacerations, and one of these patients died four hours after injury. Thirty-eight patients had minor injuries and were treated on an ambulatory basis.

3. The third accident occurred on 29 June 1945 in Bldg. 503. Here there was also an assembly line for M 13 igniters, explosion type, incendiary gasoline tank (WP). However, in this building the individual operations along the line were compartmented. An igniter functioned in cubicle seven while on the conveyor belt. Three women working at a sealing machine in the cubicle were burned. The igniter functioned after it was placed inside the packing container, but before the lid had been seamed on. The cause of the explosion was apparently the accidental arming of the fuse M-154.

One of the patients died 19 hours after injury. Another patient was critically ill but survived, and the third patient received only minor burns.

4. On 21 July 1945, a rocket charged PWP functioned while lying in a field outside Bldg. 90 E. A laborer passing by was hit by the horizontal stream of liquefied flaming PWP as it squirted from the rocket. He was severely burned but survived.

A detailed list of the patients injured in each accident is appended. (Appendix I).

B. General Information.

1. Mortality.

As a result of the four accidents 18 patients were hospitalized with burns. Nine were dead on arrival at the hospital as the result of third degree burns of approximately 90% of the body surface.

Three of the eighteen patients admitted died as the result of third degree burns of over 35% of the body surface. Two of these patients died in shock, three hours and eleven hours, respectively, after injury. The third patient died nineteen hours after injury, a delayed death due to the as yet unknown physiological-chemical factors acting in these late post-burn deaths. Seventeen hours after being burned she passed rapidly into deep coma. Respirations suddenly ceased with the thorax in inspiratory position, while the heart continued to beat for about 10 seconds.

Four patients with 8-19% third degree burns, plus additional second degree burns survived. Eleven patients with burns of 5% third degree or less also survived.

2. Treatment.

a. First aid. All WP burns were thoroughly wet down with 5% copper sulfate at the site of the accident.

b. Hospital Treatment. On arrival at the station hospital the towels and compresses over the burned areas were kept wet down with 5% copper sulfate while patients were awaiting debridement and application of dressings. Debridement consisted of removing all loose skin and particles of unburned WP with forceps and scissors. The burned areas were then dressed with petrolatum gauze and thick roll bandage.

Morphine was given in dosages necessary to relieve pain. Wherever indicated, plasma and physiological saline solution were given intravenously for the prevention or treatment of shock. The two patients dying in shock received 1500 to 2000 ml. of plasma and 1500 ml. of saline intravenously. The severely burned patients were unable to tolerate fluids by mouth in large amounts because of nausea and some vomiting. When indicated, whole blood was given early in the clinical course to combat anemia. Additional salt was given in the diet and parenterally to maintain normal electrolyte balance. In addition, one-sixth molar sodium lactate was given intravenously where needed to maintain an adequate alkali reserve.

All patients were on a high protein diet with additional vitamin B complex and 300 mg. of ascorbic acid daily. Two patients with severe burns were given one gram of ascorbic acid daily for the first week. Food was not forced in the early post-burn period when the patient was unwilling to eat.

All patients received 200,000 units of penicillin intramuscularly daily for the first two weeks of hospitalization, or as long thereafter as indicated by the presence of open wounds. Two patients had extended penicillin therapy in higher dosage because of the coincidental presence of syphilis. Five patients began to run fever, and one developed lymphadenopathy in the nodes draining the burned area, during the second week after the burn. In the wounds of three of these patients organisms of the coliform group, B proteus and pyocyaneus groups were cultured. These organisms, tested in vitro, were able to destroy fairly large amounts of penicillin. This would protect pathogens in the wound which would normally be inhibited by penicillin. This phenomenon has been reported recently in detail in a series of 80 cases by Meleney (1). Upon stopping administration of penicillin and giving oral sulfadiazine the fever and signs of invading infection subsided. Details of the bacteriological testing may be found in Appendix IV.

All patients were given tetanus antitoxin, 1500 units intramuscularly, on admission to the hospital. Patients with severe lacerations and marked muscle destruction received 20,000 units of mixed gas bacillus antitoxin in addition.

The original dressings were left in place for the first nine days. The wounds were then redressed at intervals of 7 to 10 days as required by the condition of the individual wounds. Separating slough was

removed with forceps and scissors at the time of dressing. Only petrolatum and gauze dressings were used throughout.

As soon as the third degree areas showed clean granulations, skin grafting was begun using the Padgett dermatome technique for all but very small areas. The latter were covered with pinch grafts. Skin grafting procedures, in all but two of the patients, were performed at the Hospital of the University of Johns Hopkins by Dr. Henry N. Harkins.

C. Results.

Detailed case histories, photographs and tabulations of data for individual patients may be found in Appendix II. In addition, data on the severely injured patients has been represented graphically for ease of comparison in Appendix III.

1. Hematology.

The patients with burns of 10-15% or more of the body surface all showed a leukocytosis of 20-30 thousand white cells during the first week or ten days. By the end of the second week the white blood counts had returned to near normal. Differential counts showed a predominance of polymorphonuclear neutrophiles during the elevation of the white cell count. In addition, there was a transient slight increase in eosinophiles up to 3-5%, appearing in the period between the sixth and twelfth days. This fact has been noted in the case of thermal burns before, but the significance is unknown (2).

Hemoglobin levels dropped from three to five grams below normal in the severely burned patients. One patient (Case No. 3-1945 S.B.) was admitted with a marked secondary anemia due to prolonged menorrhagia. Her red cell count was 1.8 million on admission. This responded to repeated transfusions, and after a level of 12-13 grams per cent of hemoglobin was established, the patient was able to maintain her own hemoglobin.

Two patients (Case No. 31-1945 W.M.W. and Case No. 33-1945 L.J.) developed a massive hemolysis 20 to 21 hours after injury. Their hemoglobin level dropped from around 15 grams on admission down to 5-8 grams two days later. Reticulocyte counts rose to about 5% for seven to twelve days after these episodes and then returned to normal after the patients had been repeatedly transfused. Both these patients showed a sickling trait when their venous blood was equilibrated with 100% carbon-dioxide. These two cases are discussed in more detail in section IV.

Fragility of red cells in three of the patients showed a slight increase during the first three to four days after the burn, but this rapidly returned to normal by the end of the first week.

Hematocrit readings showed relatively slight degrees of hemoconcentration.

2. Blood Chemistry.

a. Nitrogen. Serum protein levels varied between 6.0 and 7.5 gm. per cent. The lower values appeared after the first week in the severely burned patients with large granulating areas.

Plasma non-protein nitrogen, with two exceptions, rose to between 70 and 90 mg. per cent in the first 48 hours immediately after the burn and then fell to levels between 20 and 50 mg. per cent during the next two weeks in the severely burned patients who survived. In the case of No. 30-1945 (V.H.) dying 19 hours after injury, the non-protein nitrogen level rose to 375 mg. per cent. In all of the above cases the plasma alpha amino nitrogen remained normal, while the urea nitrogen level rose only slightly.

In the case of the two patients with massive hemolysis, (Case No. 31-1945 W.M.W., and Case No. 33-1945 L.J.) the serum non-protein nitrogen pattern was much different. Here the level of the non-protein nitrogen was extremely high, running to 290 mg. per cent and the alpha amino nitrogen was increased about ten times over the normal level. The urea nitrogen rose comparatively little. Both of these patients survived.

b. Electrolytes. In general the serum sodium dropped to about 120 meq./l. during the first six to eight days following the burn, after which the level rose to 135-140 meq./l. Serum potassium remained in the normal range of 12-18 mg. per cent with the exception of the two cases showing massive hemolysis. Here the level rose to 22-24 mg. per cent during the period of hemolysis and then dropped to normal within one or two days after cessation of hemolysis.

In patients with 10 per cent or more third degree burns plasma chloride levels tended to be low, ranging from 80 to 90 meq./l. immediately following the burn, and remaining around 90-95 meq./l. while there were large granulating areas of the burn uncovered by skin.

One patient (Case No. 2-1945 (P.N.) showed a marked lowering of serum chlorides. She had sustained a 20% burn (12 per cent third degree), showed little evidence of shock and was relatively well until the evening of the second day. At this time, she began to show signs of semi-stupor and delirium, and her rectal temperature rose above 103°F. A plasma chloride level of 34.2 meq./l. was reported on the third day by the Station Hospital laboratory. Twelve hours later the chlorides as determined by the authors in the Medical Division laboratory were 50 meq./l. and this checked with values obtained by the Station Hospital laboratory on the same specimen. With the addition of 25-30 grams of salt daily to her diet the chloride level rose slowly to around 90 meq./l. by the tenth day. Symptomatically the patient showed improvement on the fifth day, and her mental outlook became normal. At the time of marked hypochloremia the plasma sodium and carbon-dioxide content showed correspondingly low levels (84 meq./l. and 19.5 meq./l., respectively).

c. Carbon Dioxide Content. The content of plasma ranged between 45 and 50 vols. per cent (normal 62-65) immediately following the burn, but returned to normal within two to three days.

d. Serum Bilirubin. The level ranged as high as 3 mg. per cent during the first four days after the burn in the case of one patient, but in general there was little or no elevation above normal.

The exceptions to this statement are the two cases with hemolysis. Both showed serum bilirubin levels of 35-37 mg. per cent immediately after the cessation of hemolysis. The levels dropped to normal by the twelfth to fourteenth day after injury. There was a corresponding increase in urinary urobilinogen during this time.

3. Urine Chemistry.

a. Nitrogen. Patients with 20-30 per cent or more of the body surface burned showed an increase in urinary nitrogen output, in one case as high as 30 gm. per day. The greater part of this nitrogen was urea. The two patients showing massive hemolysis put out large amounts of protein (5-24 gm. daily) during the period of hemolysis. Proteinuria was not noted in the remainder of cases.

b. Electrolytes. Sodium and chloride excretion tended to be only slightly below normal. Potassium excretion was usually somewhat high during the first seven to ten days after the burn.

The potassium excretion of the two patients with massive hemolysis was increased particularly during the period of hemolysis.

c. Arsenic. Arsenic excretion dropped to 10 to 20 gamma per day for the first seven to ten days following the burn. Thereafter the arsenic excretion in the urine was normal, being between 60 and 90 gamma daily.

This determination was made to rule out exposure to arsenic under the conditions of the accident. In the course of the investigation, the question of possible arsine formation during the burning of WP was raised. The plant-run WP used in these munitions is extracted from phosphate rock which contains arsenic, and the plant-run material may at times carry as much as 300 parts per million of elemental arsenic.

4. Type of Burn and Application of Skin Grafts.

Two types of burn were seen in these patients. The first was due to burning of the clothing and was usually second degree. The second was due to burning of WP directly on the skin. This resulted in a deep third degree burn of all skin covered by the molten mass of WP. The skin was pale and avascular and destroyed down to and including the superficial parts of the dermis.

The two types of burn showed a clinical course similar to ordinary thermal burns. In the case of the third degree areas the thick plaque of necrotic tissue began to undergo marginal and basal autolysis toward the end of the first week. The necrotic tissue separated cleanly in about ten to twelve days leaving a bed of moderately thick granulation tissue.

Small isolated third degree burns up to about four inches in diameter were excised down to healthy tissue on the 10th to 12th post-burn day. Split thickness skin grafts were cut and sewn into place with black silk sutures at the same operation. In the cases with extensive third degree areas, necrotic tissue was allowed to separate spontaneously, assisted by some mechanical debridement at the time of dressing. These large areas were ready for skin grafting at about the 12th post-burn day. The areas were covered with multiple split thickness Padgett dermatome grafts.

In all cases the grafts took rapidly and well. At the time of first post-grafting dressing (5th day) the donor skin was adherent and the area dry.

These patients were followed for one year after injury. The grafted areas exhibited the usual return of sensation in three to four months. Keloid formation was minimal, being most marked in those patients of the colored race.

D. Discussion.

1. Possible Absorption of WP with Production of Systemic Phosphorus Poisoning.

The question of absorption of elemental phosphorus from the burn site with resultant liver and kidney damage has often been raised. A recent report from this laboratory, on phosphorus containing compounds found in the skin following experimental WP burns, indicated that any phosphorus remaining in the tissues was in the form of ortho-phosphate, and as such was not capable of systemic toxic effects (3).

In our opinion none of these patients suffered systemic effects due to absorbed unburned WP. Serum bilirubin levels and quantitative bromsulfalein retention studies showed no evidence of liver damage (Appendix V). The high serum bilirubin levels reported in the two patients showing hemolysis we believe are the result of massive blood destruction and not of marked liver damage.

It has been reported that patients with phosphorus poisoning show low blood sugar levels and low serum calcium levels (4). Fasting blood sugar levels in the seriously injured patients were normal on several occasions, as were the serum calcium levels.

Phosphate excretion in the urine was followed on the theoretical basis that an absorption of phosphorus-containing compounds might be followed by an increased phosphate excretion. Phosphate excretion proved to be somewhat reduced rather than increased for the first seven to fourteen days following the burn.

There were circumstances, however, in this series of accidents under which absorption of unburned WP was possible. Two patients had deep lacerations of neck and arms and during debridement particles of unburned WP were found deep in the tissues where they had been driven by the force of the explosion. The British have reported a case of systemic effects of WP following a bullet wound, where an incendiary bullet lodged in perirenal fat tissue (5).

2. Elevation of Plasma Non-Protein Nitrogen.

In a series of human patients with thermal burns reported under OEMcmr 280 (6), it was noted that there was a rise in an undetermined fraction of the plasma non-protein nitrogen, and that the magnitude of rise was associated directly with the severity of injury and with the prognosis. No patient with an elevation of plasma non-protein nitrogen over 100 mg. per cent survived.

In the series of cases reported here, there are several examples of this phenomenon, but there are also two exceptions.

Case No. 3-1945 (S.B.) showed a rise of 95 mg. per cent on the fourth day and then a drop back towards normal. The values remained somewhat elevated, however, while there were large areas of granulating tissue uncovered by skin.

Case No. 30-1945 (V.H.) showed a marked rise to 370 mg. per cent seventeen hours after injury and died nineteen hours after injury.

Case No. 2-1945 (P.N.) showed a rise to 65 mg. per cent a few days after the burn.

The two cases with massive hemolysis reported here show a much different picture. Case No. 31-1945 (W.M.W.) with a 15% burn showed a striking increase in non-protein nitrogen with the onset of hemolysis reaching 290 mg. per cent on the fifth day. Coincidentally the plasma alpha amino acid nitrogen rose to 64.3 mg. per cent. Case No. 33-1945 (L.J.) showed practically the same picture.

This differs from the plasma non-protein nitrogen pattern seen following thermal burns in two respects. First, the rise in total non-protein nitrogen is disproportionately high with respect to the amount of burn. Secondly, there is a marked rise in the plasma alpha amino acid nitrogen level in these two cases, while following the usual thermal burn there is no increase in alpha amino acids.

These findings suggest two possibilities; first, that the rise in non-protein nitrogen is simply a non-specific indicator of tissue damage; or second, that there is a qualitative as well as quantitative difference in the components of plasma non-protein nitrogen following different types of tissue destruction. The rise in plasma alpha amino acid nitrogen in these two cases is possibly due in large part to the release of amino acids on breakdown of the erythrocyte. The amino acid content of the normal erythrocyte is three to five times as high as that of the plasma.

3. Hemolysis.

Reference has been made in the foregoing portions of this report to two patients who showed a curious type of hemolysis.

Both these patients were colored people, 18 and 19 years of age, respectively, who gave no evidence of blood dyscrasia in their past

medical history. Case No. 33-1945 (L.J.) had a primary luetic chancre of one week's duration. Initial blood and urine examinations showed no evidence of hemolysis or hemoglobinuria. Twenty to twenty-six hours after injury they began to show hemoglobinemia and hemoglobinuria which persisted in Case No. 31-1945 for eighty-eight hours, and in Case No. 33-1945 for seventy-two hours. Plasma carbon-dioxide content at the onset of hemolysis was about 50 vol. per cent, and intravenous one-sixth molar sodium lactate was accordingly given to maintain the alkali reserve and to insure an alkaline urine. Methemoglobin in the blood was 6-10%, intracellular for the most part in Case No. 31-1945 and extra-cellular in case No. 33-1945. Upon cessation of the hemolysis, plasma and urine cleared rapidly of hemoblobin. Renal function as tested by the ability to clear para-amino hippuric acid was normal in both cases. Following hemolysis, the serum bilirubin level rose to around 35 mg. per cent but dropped back to normal within ten to twelve days following the injury.

The erythrocytes appeared morphologically normal upon examination of the stained smear. Tests for the presence of auto-agglutinins and auto-hemolysins in the patient's plasma, and for agglutinins and hemolysins in the pooled plasma given to combat shock, proved negative.

In both cases it was possible to demonstrate a sickling trait in the venous blood upon equilibration with 100% carbon-dioxide. Similar tests on other patients showed no sickling traits. Clinically these patients did not show the characteristic chills, high fever and swollen joints of the patients with a sickling crisis. We have no explanation for this phenomenon at the present time.

E. Summary.

1. A report is presented on 27 casualties with WP burns resulting from four accidents in plants processing WP munitions at Edgewood Arsenal, Md.

2. Nine patients were dead upon arrival at the Station Hospital as the result of third degree burns of 90% or more of the body surface in each case. Eighteen patients with WP burns were admitted to the hospital. Three of these patients with third degree burns of 35% or more of the body surface died within 19 hours after admission to the hospital. The remaining fifteen patients survived. Four of these had third degree burns of 8-19% of the body surface, in addition to second degree burns. Eleven of the patients had burns of 5% or less area third degree.

3. Detailed data are presented on six patients who were most severely burned. Two of the patients developed an as-yet-unexplained massive hemolytic reaction about 24 hours after injury and lasting around 80 hours.

4. There was no evidence of systemic injury due to absorption of unburned WP through the burned areas.

5. The burn cases followed a clinical course indistinguishable from that of the usual deep third degree thermal burn.

IV. RESPIRATORY COMPLICATIONS.

A. General Situation.

When the second in this series of accidents occurred in Bldg. 509 on 25 May 1945, there were eight women in the washroom of the building at the time of the accident. The washroom opened into the large assembly line room at a point about fifty feet from the air vise. Four of the women escaped immediately and suffered no injury. The remaining four were trapped in the washroom for fifteen to twenty minutes until the fires were extinguished and they were able to escape.

The small room quickly became filled with smoke which was variously described as dense, white, grey and black. The patients could feel the intense heat of the fire in the adjoining factory, and some were spattered by debris from the explosions.

In no instance was there loss of consciousness, and they were able to walk out of the building once the fire was under control.

B. Symptoms on Admission to Station Hospital.

All of the four patients who remained in the washroom developed respiratory symptoms. They reported the prompt onset with varying severity of a choking sensation, a feeling of suffocation, a sense of tightness in the chest, cough, expectoration of tenacious sputum and a soreness in the throat. Two patients were hoarse. One patient had WP spatter burns of minor nature. There were no other complaints.

C. Physical Findings on Admission to Station Hospital.

The physical findings were generally the same in all four patients, but varying in intensity. They were restless, anxious, distressed by cough and non-frothy expectoration; two were moderately short of breath and hoarse. There was no instance of cyanosis, orthopnoea or distension of neck veins. There was no injection of the corneae, sclerae or mucous membranes of the nose, mouth or pharynx. Respirations were regular, moderately rapid and not shallow. Chest expansion was not limited. Numerous sibilant and sonorous rales were heard throughout the lung fields. Otherwise the lungs were normal. The remainder of the physical examination was normal save for minor bruises or spatter burns.

D. Discussion.

Detailed case histories are collected in Appendix VI. Graphic representation of data, and chest x-rays are collected in Appendix VII.

Although the respiratory tract injury in these patients cannot be ascribed solely to WP smoke, it seems from the nature of the accident that it was the predominant factor. In addition to the white phosphorus there were other inflammable materials present from which irritating products of combustion may have arisen. However, definite data on these materials are not available. The absence of burns about the face

and upper part of the body indicates that the direct effect of the flame was not a factor in the respiratory tract injury. It is also noteworthy that the sputum expectorated did not contain noticeable amounts of soot, commonly described in respiratory tract irritation sustained during conflagrations.

The smoke of burning WP is composed of particles of phosphorus pentoxide, which reacts readily with water vapor to form phosphoric and pyrophosphoric acids. In high concentrations of WP smoke, it is possible that not all phosphorus pentoxide is converted to phosphoric acid by atmospheric water vapor. Some of the pentoxide may react with water vapor in the respiratory tract producing local injury by the heat of this reaction, as well as by the local irritant effect of phosphoric acids.

Extensive field trials and combat experience with WP munitions indicate that the concentrations of WP smoke ordinarily obtained in the field are non-irritating and non-toxic. However, laboratory studies in men exposed in a gassing chamber to concentrations of white phosphorus smoke considerably less than the maximum assumed obtainable in the field (1 mg./l.) indicate that three to fifteen-minute exposures are toxic as well as irritating (7). The observers in these chamber experiments developed soreness and tightness of the throat that was aggravated by talking for even a few minutes. They also experienced tightness in the chest, cough, increased nasal discharge and a bronchitis which, in some instances, lasted three to four days.

The casualties of the WP explosions exhibited similar but more severe symptoms. The observations made in these patients indicate that a high concentration of WP smoke may develop quickly in a relatively closed space and produce immediate casualties from respiratory tract injury.

A fairly definite pattern of respiratory tract injury in these patients may be found by assembling the clinical, laboratory and roentgenographic data.

The prompt partial symptomatic relief from respiratory distress in Case 1-C.J. and Case 2-S.E. upon subcutaneous administration of adrenalin shortly after admission indicates the presence of bronchiolar constriction. Both these patients were hoarse and exhibited erythema and edema of the larynx and vocal cords. Injury apparently extended well down the bronchial tree since the patients expectorated bronchial casts (Fig. 1 A, Appendix VII). Microscopic examination showed that the casts contained the necrotic superficial layer of bronchial epithelium (Fig. 1 B and 1 C, Appendix VII).

In both cases chest x-ray showed patchy areas of infiltration. These areas cleared within five to ten days, whereas clinical evidence of injury to the larynx, trachea and bronchi persisted for a much longer time. There were no clinical or roentgenographic signs of atelectasis or emphysema which one might expect in view of the bronchial casts.

In Case 1-C.J. cough and expectoration were so frequent and intense during the first week that they interfered with ingestion of

liquid and semi-solid food. Both Case 1-C.J. and Case 2-S.E. experienced some relief from coughing upon inhalation of oxygen by nasal mask (6 to 8 l./min.).

Injury may be limited to the trachea and bronchial tree, as in Case 3-E.S. and Case 4-R.M. These patients were not hoarse, exhibited normal x-ray findings, but had numerous sibilant and sonorous rales throughout the lung fields, accompanied by cough and expectoration for several days. Both these patients were less severely injured than Case 1-C.J. and Case 2-S.E.

It is interesting to note that none of these patients exhibited irritation of their eyes, nose or throat.

Hoarseness may persist long after other evidence of respiratory tract irritation disappears. In case 2-S.E. the lungs were clear and the cough and expectoration had subsided by the seventh day, but the hoarseness did not begin to subside until the thirteenth day. The return of voice is not yet complete, for the patient has experienced intermittent periods of hoarseness, occasionally associated with a "cold", during the eight months since discharge from the hospital.

In Case 1-C.J., the most seriously injured in the group, hoarseness has improved only slightly. Three months after injury it was necessary to cut a band of scar tissue which formed across the anterior portion of the vocal cords. When seen eight months after the original injury the patient was just beginning to be able to speak in a low, husky voice.

Lipiodol bronchiograms performed on the three patients in whom there was reason to suspect the possible development of bronchiectasis (Cases 1-C.J., 2-S.E., and 3-E.S.) appeared normal. Bronchiograms were repeated six months after injury and were normal at this time as well.

There was no clinical evidence of systemic absorption of WP or phosphine by way of the lungs.

E. Summary.

The case records are presented on four patients who accidentally inhaled white phosphorus smoke in a relatively enclosed space for fifteen to twenty minutes. These patients sustained respiratory tract injury ranging from tracheobronchitis to laryngo-tracheo-broncho-pneumonitis. Eight months following the accident the only sign of residual damage has been hoarseness in two cases.

V. CONCLUSIONS.

1. First aid treatment with 5% copper sulfate solution followed by careful debridement of the burned area is essential in order that unburned WP may be removed.

2. Any lacerated wounds should be carefully debrided to remove possible deeply embedded particles of unburned WP.

3. Aside from the above first aid measures, the treatment of the WP burn in the human being is the same as that of any thermal burn of similar severity.

VI. RECOMMENDATIONS.

None

VII. BIBLIOGRAPHY.

1. Meleney, F. L., and Whipple, A. O., "Statistical Analysis of Study of Prevention of Infection with Special Reference to Sulfonamides." Surg., Gyn. and Obstet. 80: 263-296, (March) 1945.

2. Wilson, W. C., Macgregor, A. R. and Stewart, C. P., "The Clinical Course and Pathology of Burns and Scalds under Modern Methods of Treatment." Brit. J. Surg. 25: 826-865, (April) 1938.

3. Walker, J. Jr., Wexler, J., and Hill, M. L., "Quantitative Analysis of Phosphorus-containing Compounds formed in WP Burns.", Medical Division Report No. 37, (20 June) 1945.

4. Greenberg, D. M., "Influence of Certain Liver Poisons on Action of Parathyroid Extract." Proc. Soc. Exper. Biol. and Med. 34: 622-626, 1936.

5. Godding, E. W. and Notton, H. E. F., "The Treatment of Phosphorus Burns." Brit. Med. J. 1: 433, (4 April) 1942.

6. Walker, J. Jr., "A Study of the Azotemia observed after Severe Burns.", Surgery 19: 825-844, (June) 1946.

7. White, S. A. and Armstrong, G. C., "White Phosphorus Smoke. Its Irritating Concentration for Men and Its Toxicity for Small Animals for One-Hour Exposures." EATP 190, (19 May) 1943.

APPENDIXES

APPENDIX I

LIST OF PATIENTS

APPENDIX I

List of Patients Injured in WP Accidents.

Case Number	Age	% burn	% third degree	Result
17 May 1945				
No. 1-1945 (B.C.)	28	10%	5%	survived
No. 2-1945 (P.N.)	24	20%	12%	survived
25 May 1945				
No. 3-1945 (S.B.)	33	20%	19%	survived
No. 4-1945 (S.H.)	38	15%	2%	survived
No. 5-1945 (L.P.)	42	10%	4%	survived
No. 6-1945 (R.M.)	23	5%	1%	survived
No. 7-1945 (A.F.)	30	5%	4%	survived
No. 8-1945 (M.S.)	30	7%	3%	survived
No. 9-1945 (M.N.)	48	9%	0%	survived
No. 10-1945 (S.J.)	50	8%	3%	survived
No. 11-1945 (G.Z.)	58	6%	1%	survived
No. 13-1945 (K.C.)	19	8%	2%	survived
No. 16-1945 (C.P.)	44	50%	45%	died 11 hr.
No. 17-1945 (C.C.)	28	65%	60%	died 3 hr.
No. 20-1945 thru No. 28-1945		90%	90%	died almost instantly.
29 June 1945				
No. 30-1945 (V.H.)	34	40%	35%	died 19 hr.
No. 31-1945 (W.M.W.)	19	15%	8%	survived
No. 32-1945 (S.M.)	28	5%	1%	survived
21 July 1945				
No. 33-1945 (L.J.)	18	25%	15%	survived

APPENDIX II

CASE HISTORIES, PHOTOGRAPHS, AND TABULATIONS OF DATA FOR INDIVIDUAL PATIENTS

Case No. 1-1945 (B.C.)

This 28 year old colored girl sustained a 10% burn (5% third degree) of the hands and face. She showed no marked systemic reaction.

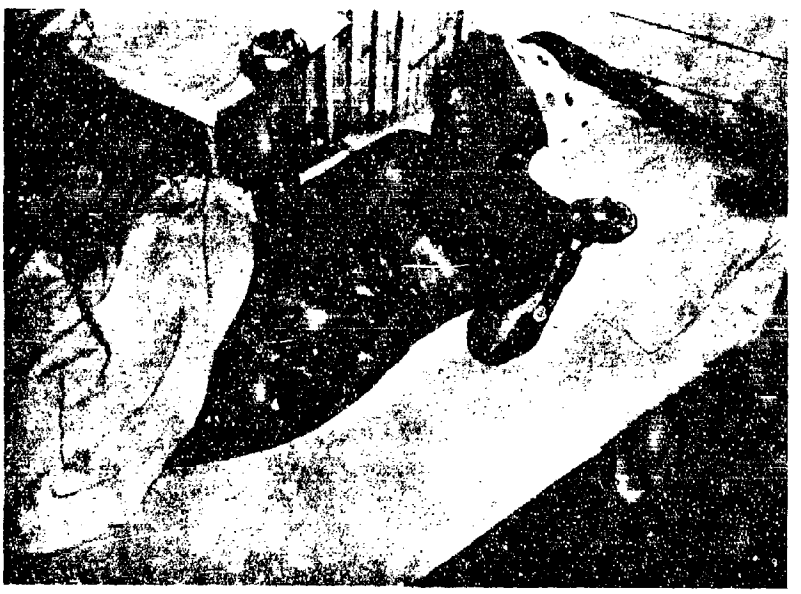
Plastic surgery was necessary to repair the facial defects, particularly the third degree spot burns of the eyelids which resulted in contractures.

Case No. 2-1945 (P.N.)

This 24 year old colored girl received a 20% burn (12% third degree) involving both arms, both breasts and the abdomen. The areas on the abdomen were particularly deep due to the ignition of a synthetic rubber girdle by the flames. She showed little evidence of shock, and the highest hematocrit reading was 43% on the evening of the first day. She remained relatively well until the evening of the second day, some 30 hours after the burn, at which time she began to show signs of semi-stupor and delirium. Her rectal temperature rose above 103°F. On the morning of the third day her plasma chloride value was reported as 34.2 mEq./l. by the Station Hospital laboratory. In spite of plasma and saline administration, her chlorides rose only very slowly. On the evening of the third day plasma chlorides as determined by this laboratory were 50 mEq./l., and this checked with values obtained by the Station Hospital laboratory at the same time on the same sample. The plasma chlorides rose slowly over a period of seven days to around 90 mEq./l. and remained near this level. Plasma sodium and carbon-dioxide content showed correspondingly low levels (84 mEq. and 19.5 mEq./l.), respectively, on the third day. Symptomatically the patient showed improvement on the fifth day, and her mental outlook became normal. The plasma non-protein nitrogen reached a value of 65 mg. on the third day and declined thereafter to slightly above normal.

On the evening of the ninth day, the patient again showed a rise in temperature to above 104°F., in spite of the continued administration of penicillin. Wound culture showed the presence of B. pyocyaneus. Penicillin administration was stopped, and sulfadiazine administration started on the tenth day. The temperature and pulse slowly declined to just above normal by the fourteenth day. Subsequent bacteriological analysis showed that this organism was capable of destroying moderately large amounts of penicillin *in vitro*. It is probable that this allowed growth of pathogens in the wound which had previously been held in check by the penicillin.

This patient required fairly extensive skin grafting, using the Padgett dermatome technique. All grafted areas healed satisfactorily with the exception of the area on the upper lid of the left eye. Here a contracture still prevents complete closure of the lid. An excision of the scar and reapplication of a graft is to be done in the near future.



CASE No.2-1945-(P.N.)

CASE No. 2-

-1945-(P.N.)

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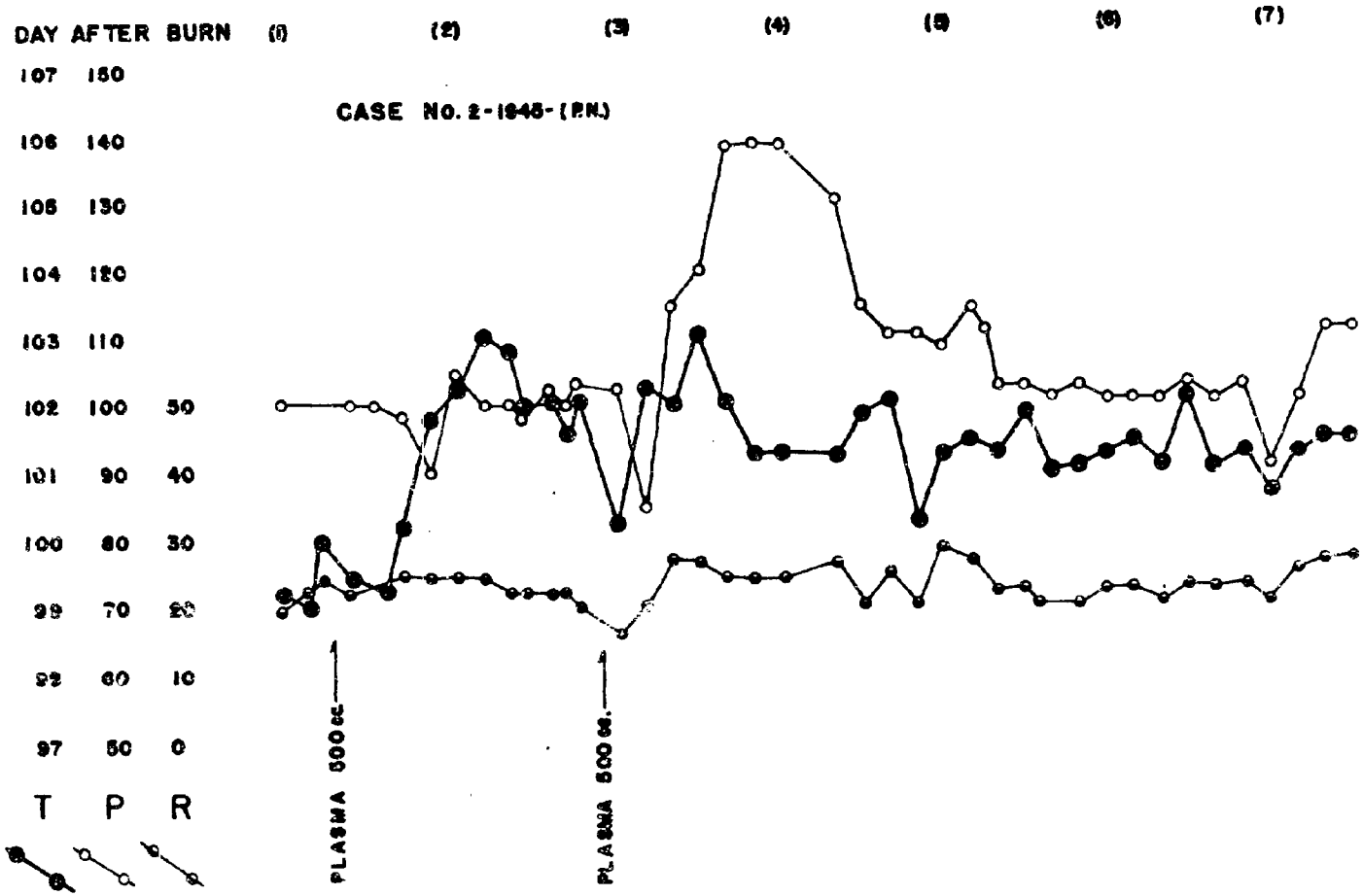
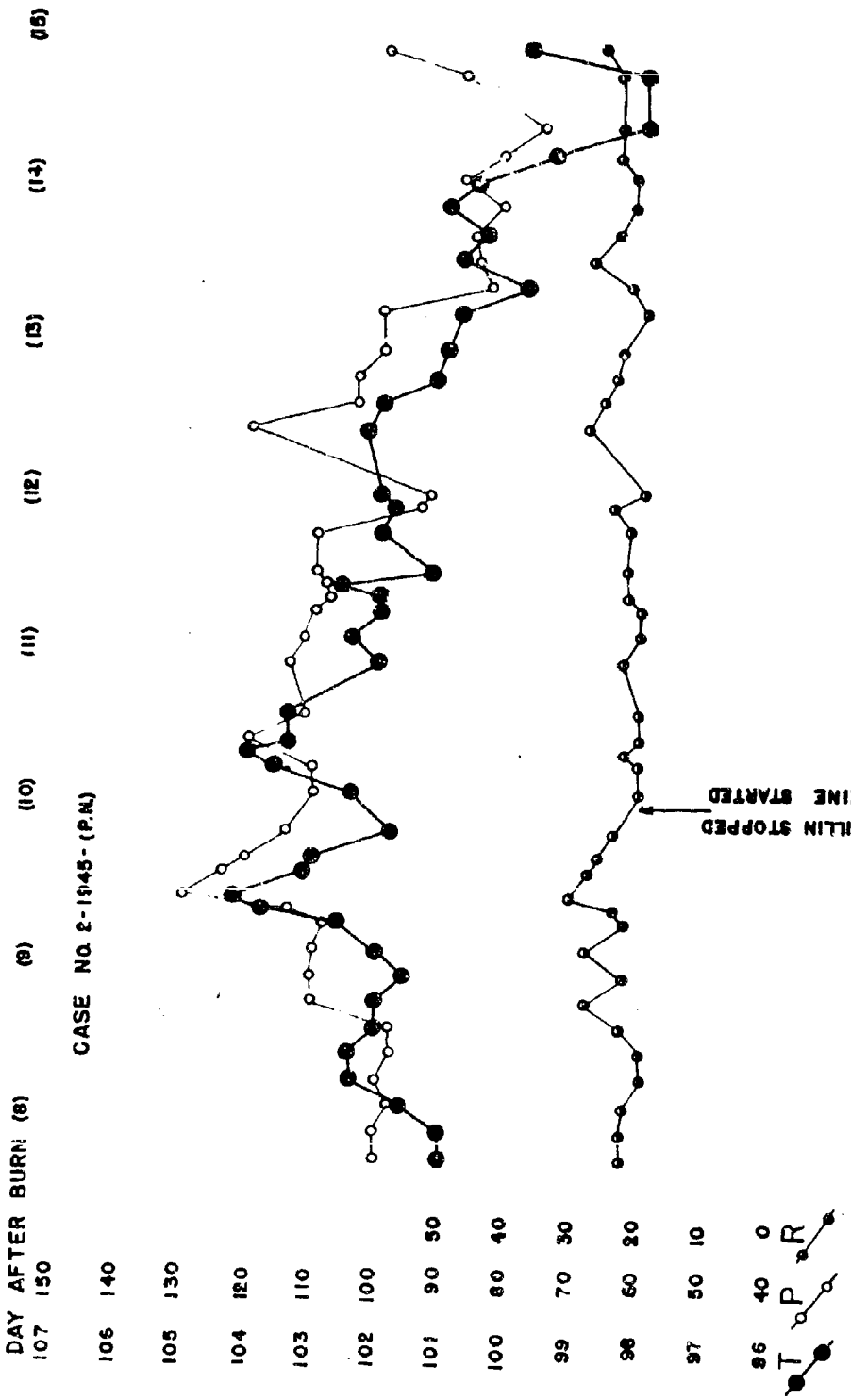


Temperature, Pulse and Respiration

Phase II. Determination of the LD50.



Temperature, Pulse and Respiration
26

PLASMA ELECTROLYTES

Case No. 2-1945 (P.N.)

Day After Burn	Sodium		Potassium		Chloride		CO_2	
	mg./ 100 ml.	mEq./ liter	mg./ 100 ml.	mEq./ liter	mg./ 100 ml.	mEq./ liter	Vols %	mEq./ liter
(1)								
(2)								
(3)	193	84			122	34.2	45	19.5
(4)	212	92			178	50	52	22.6
(5)	286	124			320	90	55	23.9
(6)	276	120			298	84	58	25.2
(7)	311	135					60	26.1
(8)	304	132			308	87	59	25.6
(9)							60	26.1
(10)	313	136	19.5	5.5	316	89	61	26.5
(11)							58	25.2
(12)	308	134	20.7	5.8	301	85	58	25.2
(13)								
(14)	322	140	15.8	4.5	354	100	6[illegible]	27.8
(15)								
(20)	340	148	15.8	4.5	336	95		

URINARY ELECTROLYTE CONTENT

(24 hour output given as grams and equivalents)
Case No. 2-1945 (P.N.)

Day After Burn	24 hr. Vol ml.	Sodium gm./	Sodium Eq./	Potassium gm./	Potassium Eq./	Chloride gm./	Chloride Eq./	Phosphate gm./	Phosphate Eq./
(11)	1800	2.16	0.094	2.87	0.073	1.87	0.053	5.21	0.082
(12)	2200	5.17	0.225	1.43	0.037	6.73	0.190	1.51	0.024
(13)	2150	2.63	0.114	1.78	0.046	4.73	0.133	1.85	0.029
(14)	1825	2.56	0.111	2.02	0.052	2.96	0.083	2.14	0.034
(15)	2330	4.43	0.193	2.91	0.074	4.53	0.128	2.90	0.046
(16)	1975	2.86	0.124	2.52	0.065	3.95	0.111	2.69	0.042
(17)	1960	1.57	0.068	2.26	0.058	2.20	0.062	2.22	0.035
(18)	2440	2.93	0.127	2.20	0.056	3.61	0.102	2.31	0.036
(19)	2270	2.61	0.113	3.06	0.078	2.95	0.083	2.71	0.043
(20)	2870	3.87	0.168	3.30	0.085	5.10	0.144	3.65	0.057
(21)	1710	2.14	0.093	2.48	0.063	3.35	0.094	2.72	0.043
(22)	1915	0.86	0.037	1.72	0.044	1.49	0.042	2.08	0.033
(23)	1670	1.01	0.044	1.51	0.039	1.14	0.032	1.88	0.030
(24)	2460	1.97	0.086	2.89	0.074	3.20	0.090	1.93	0.030
(25)	3350	2.34	0.102	2.01	0.051	2.34	0.066	1.75	0.028
(26)	3260	1.89	0.078	2.85	0.073	1.75	0.049	1.37	0.022
(27)	3390	1.36	0.059	1.95	0.050	1.15	0.032	0.98	0.015
(28)	2100	1.36	0.059	1.31	0.034	1.47	0.041	0.76	0.012
(29)	700	0.35	0.015	0.63	0.016	0.42	0.012	0.54	0.008
(30)	3910	1.77	0.077	1.47	0.038	1.57	0.044	1.45	0.023

URINARY NITROGEN CONTENT

Case No. 2-1945 (P.N.)

Day After Burn	24 Hour Volume in ml.	Non-Protein Nitrogen gm./24 hr.	Urea Nitrogen Gm./24 hr.
(11)	1800	22.32	17.45
(12)	2200	8.32	6.84
(13)	2150	5.50	3.55
(14)	1825	3.76	2.01
(15)	2330	9.94	9.13
(16)	1975	4.83	3.14
(17)	1960	10.79	8.50
(18)	2440	8.05	5.86
(19)	2270	11.92	11.76
(20)	2870	8.05	5.77
(21)	1710	6.84	4.07
(22)	1915	2.34	2.30
(23)	1670	3.06	1.32
(24)	2460	6.60	4.22
(25)	3350	1.20	0.85
(26)	3260	9.94	6.16
(27)	3390	6.21	3.12
(28)	2100	3.09	3.04
(29)	700	3.73	1.75

Case No. 3-1945 (S.B.)

This 33 year old colored woman received a 20% burn (19% third degree), involving the back and both arms, as well as the back of the head and neck. She showed remarkably little systemic reaction to this injury. Plasma chloride and sodium remained only slightly below normal during the immediate post-burn periods. The plasma non-protein nitrogen rose to a peak value of 95 mg.% on the fourth day and then returned towards normal.

During the second week she developed fever, and the wound culture showed B. proteus in large numbers. She had been receiving penicillin since the day of admission. The penicillin administration was stopped and sulfadiazine was started. The fever subsided gradually from the eighth to the eleventh day. This organism also showed the ability to destroy penicillin *in vitro*.

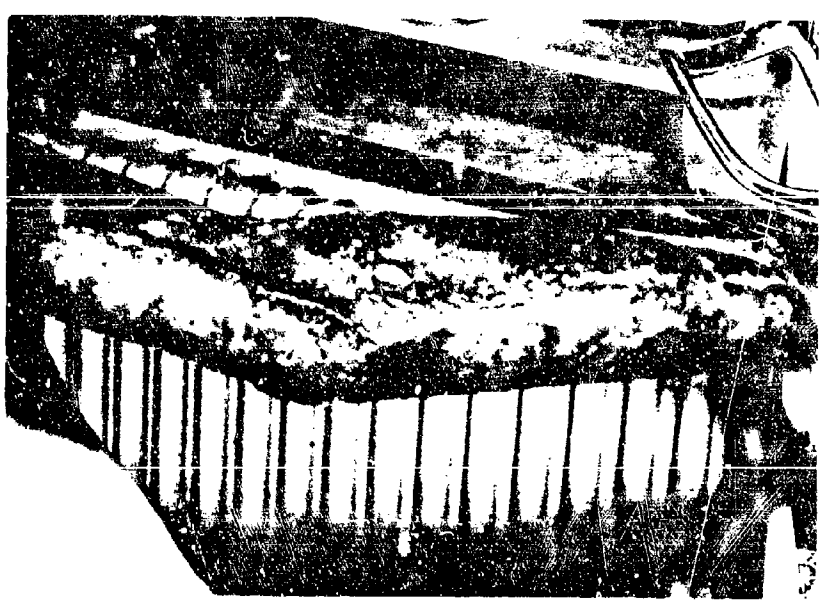
The anemia shown by this patient apparently had existed for at least a year prior to admission. It was a secondary anemia, on the basis of menorrhagia. The patient was transfused repeatedly during the first ten days after admission, and when a moderately high level of hemoglobin had been attained, the patient was able to maintain it when given oral iron.

The thick leathery slough was separated for the most part by the fifteenth day, and multiple Padgett dermatome grafts were applied to the granulating areas with excellent results. She has made a complete recovery, and at the present time has developed no contractures.

CASE No.3-1945-(S.B.)

CASE No.3-

-1945-(S.B.)



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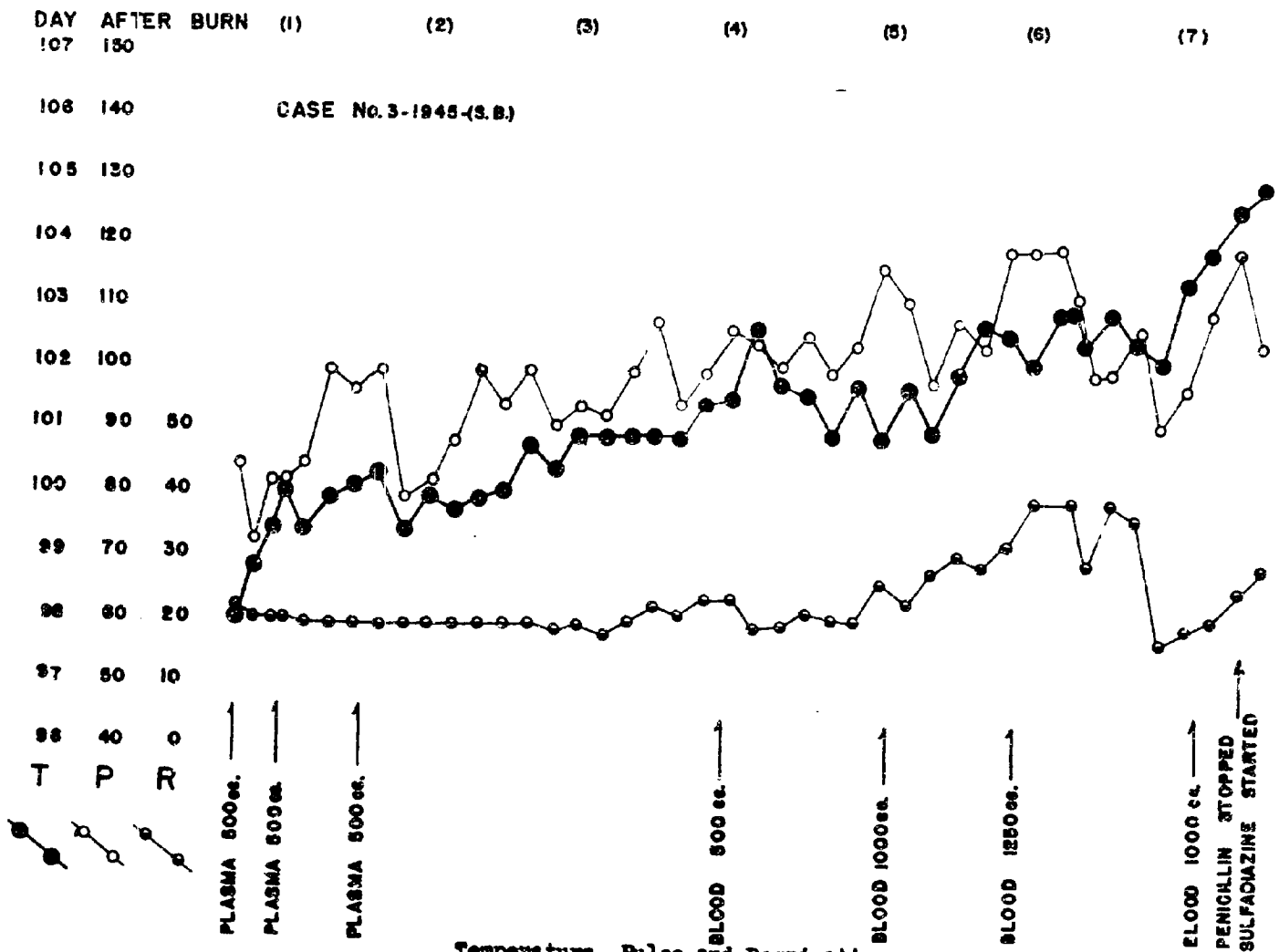
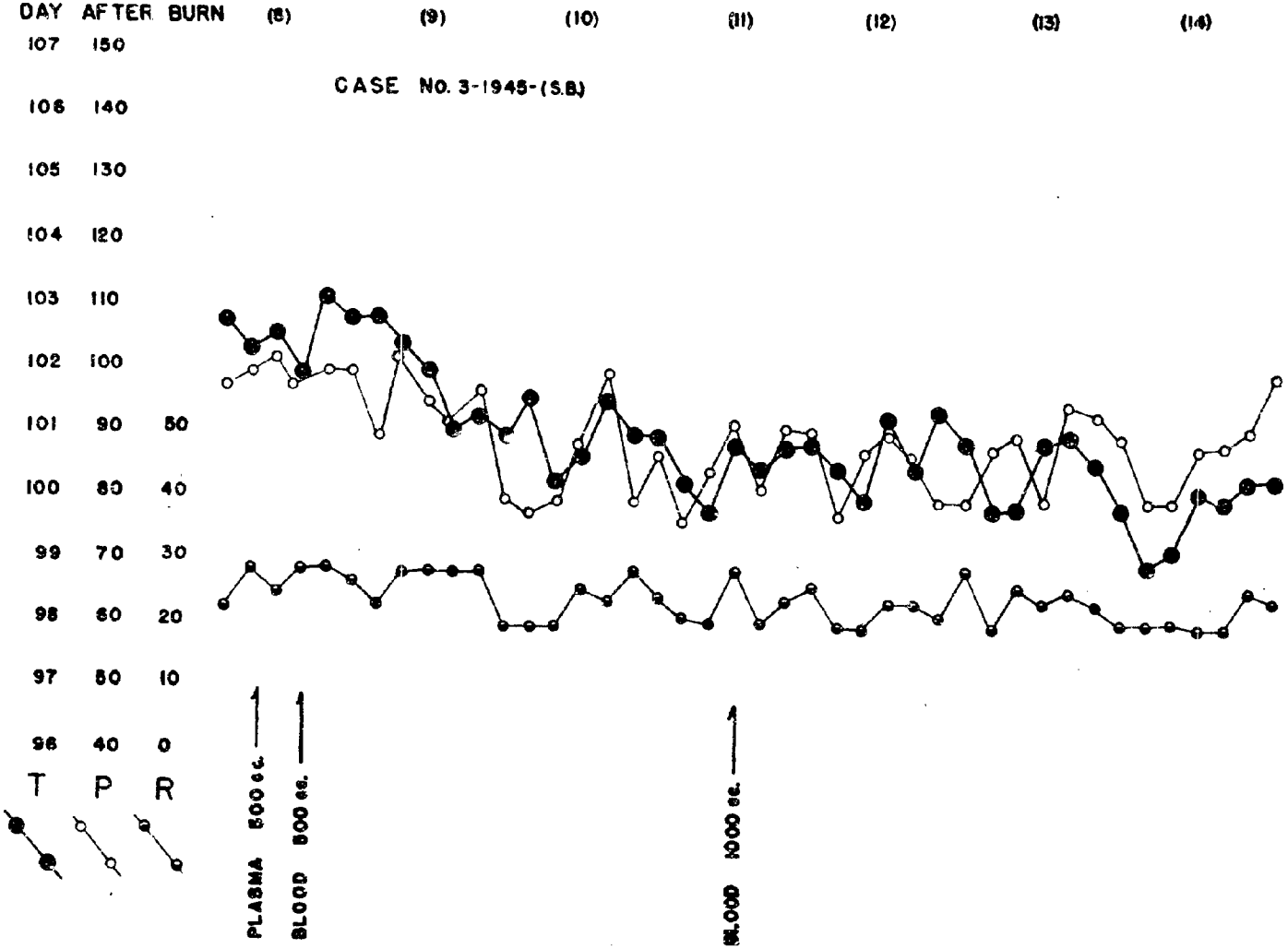
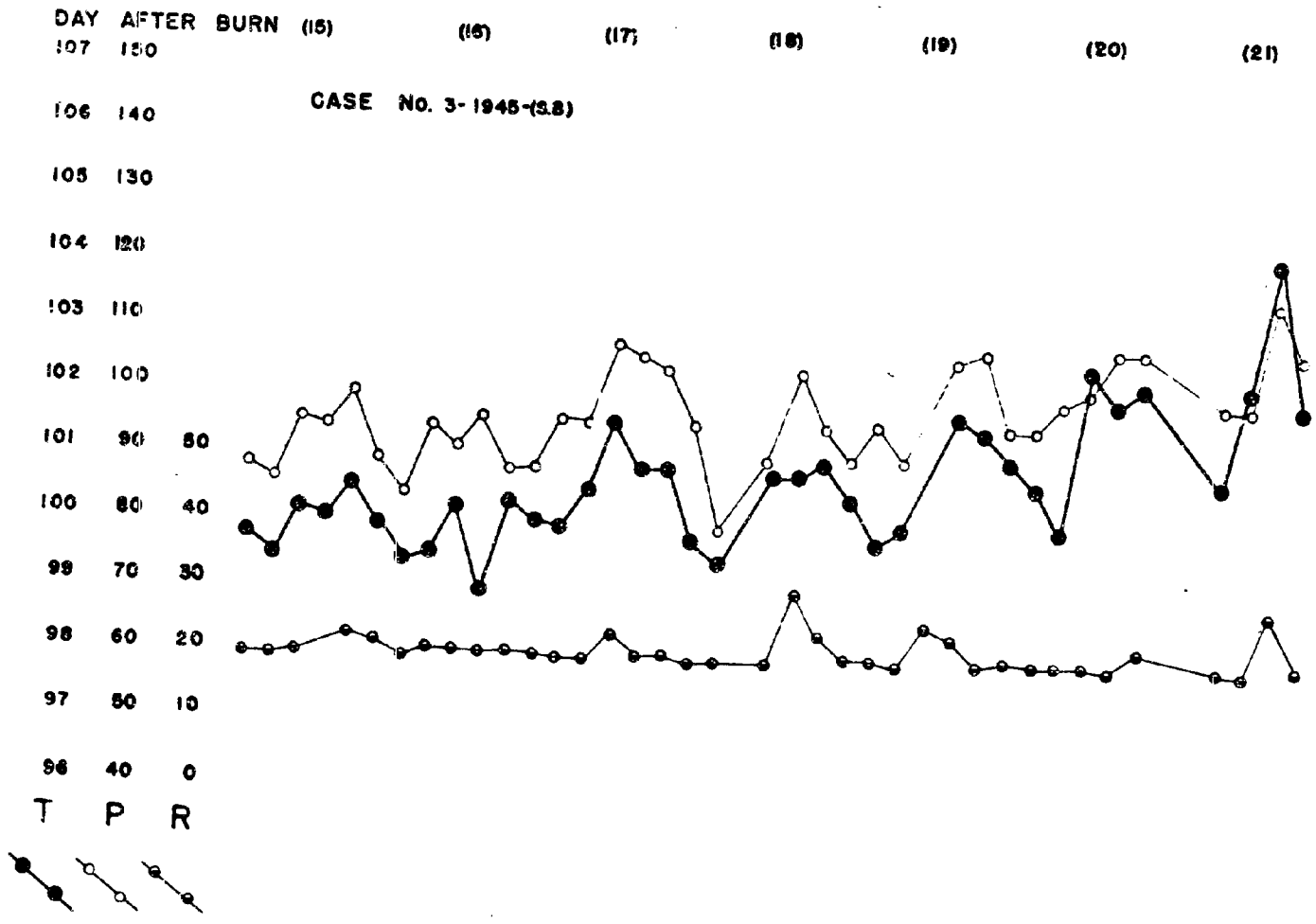


Temperature, Pulse and Respiration



Temperature, Pulse and Respiration



CASE No. 3- 1945-(3.8)

Temperature, Pulse and Respiration

PLASMA ELECTROLYTES

Case No. 3-1945 (S.B.)

Day After Burn	Sodium		Potassium		Chloride		CO_2	
	mg./ 100 ml.	mEq./ liter	mg./ 100 ml.	mEq./ liter	mg./ 100 ml.	mEq./ liter	Vols %	mEq./ liter
(1)								
(2)	276	120	18.0	4.6	344	97	52	22.6
(3)	272	118			337	95	58	25.2
(4)	285	124	16.0	4.1				
(5)	299	130	15.5	4.2	370	104	64	27.8
(6)	294	128	17.5	4.5	341	96	60	26.1
(7)	311	135			289	82	62	26.9
(8)	306	133						
(9)	322	140						
(10)								
(11)	313	136	19.0	4.9	358	101	65	28.2
(12)					363	102	64	27.8
(13)	322	140						
(14)					367	104	65	28.2
(15)	322	140	19.5	5.0				

PLASMA NITROGEN CONTENT

Case No. 3-1945 (S.B.)

Day After Burn	Protein	Non-Protein Nitrogen	Urea Nitrogen	Alpha Amino Nitrogen
	gm./ 100 ml.	mg./ 100 ml.	mg./ 100 ml.	mg./ 100 ml.
(1)				
(2)	7.2	30.5	18.0	6.0
(3)		50.0		7.0
(4)		95.0		
(5)		70.0	20.0	7.5
(6)	6.6			
(7)				
(8)		36.0	17.0	6.0
(9)				
(10)				
(11)	7.2	38.0	8.0	7.5
(12)				
(13)		35.0		
(14)				
(15)				
(16)	7.3	40.0	15.0	6.0
(17)				
(18)				
(19)		35.0	12.0	
(20)				
(21)				
(22)	7.2	25.0	15.0	

URINARY ELECTROLYTE CONTENT

(24 hour output given as grams and equivalents)

Case No. 3-1945 (S.B.)

Day After Burn	24 Hr. Vol. ml.	Sodium		Potassium		Chloride		Phosphate	
		gm.	Eq.	gm.	Eq.	gm.	Eq.	gm.	Eq.
(2)	460	0.97	0.042	1.17	0.030	2.02	0.057	0.10	0.002
(3)	1200	1.26	0.055	0.68	0.017	2.42	0.068	0.43	0.007
(4)	1800	3.60	0.157	0.99	0.025	6.08	0.171	0.20	0.003
(5)	1820	5.37	0.234	1.41	0.036	3.90	0.110	0.69	0.011
(6)	2787	10.46	0.455	2.23	0.057	15.00	0.422	0.08	0.001
(7)	1380	4.14	0.180	1.14	0.029	6.30	0.177	0.09	0.001
(8)	1830	6.22	0.270	1.14	0.029	7.70	0.217	2.22	0.035
(9)	1380	2.07	0.087	0.73	0.019	2.98	0.084	0.37	0.006
(10)	2650	3.85	0.167	1.72	0.044	6.05	0.170	0.80	0.013
(11)	1875	4.68	0.203	1.78	0.046	4.02	0.113	1.50	0.024
(12)	2125	3.93	0.171	1.86	0.048	6.16	0.174	1.34	0.021
(13)	1588	3.25	0.141	1.83	0.047	4.50	0.127	1.83	0.029
(14)	2250	3.09	0.134	2.33	0.060	4.43	0.125	2.01	0.033
(15)	2170	2.93	0.127	2.82	0.072	4.35	0.123	2.35	0.037
(16)	3000	5.10	0.222	4.05	0.104	8.40	0.236	2.67	0.042
(17)	1800	1.44	0.063	1.53	0.039	2.36	0.066	1.43	0.022
(18)	1640	2.38	0.104	2.59	0.066	3.61	0.102	1.67	0.026
(19)	1300	1.88	0.082	2.37	0.061	2.84	0.080	1.01	0.016
(20)	1900	2.10	0.091	2.56	0.065	3.68	0.104	1.12	0.018
(21)	2580	1.29	0.056	2.32	0.059	4.88	0.137	1.57	0.025
(22)	2060	2.78	0.121	1.91	0.049	3.67	0.103	1.59	0.025

URINARY NITROGEN CONTENT

Case No. 3-1945 (S.B.)

Day After Burn	24 hour volume in ml.	Non-Protein Nitrogen gm./24 hr.	Urea Nitrogen gm./24 hr.
(1)	460	5.20	3.88
(2)	1200	2.82	2.42
(3)	1800	3.06	2.48
(4)	1820	0.44	0.44
(5)	2787	1.03	0.67
(6)	1380	6.90	5.38
(7)	1830	5.83	4.25
(8)	2650	1.94	1.90
(9)	1875	9.20	7.33
(10)	2125	5.49	4.85
(11)	1588	4.84	4.46
(12)	2250	6.87	5.22
(13)	2170	4.47	1.32
(14)	3000	10.62	10.16
(15)	1800	4.83	1.26
(16)	1640	3.60	2.00
(17)	1300	6.04	4.25
(18)	1900	6.73	5.90
(19)	2580	6.92	4.42
(20)	2060	5.77	4.78
(21)			

HAEMOTOLOGY

Case No. 3-1945 (S.B.)

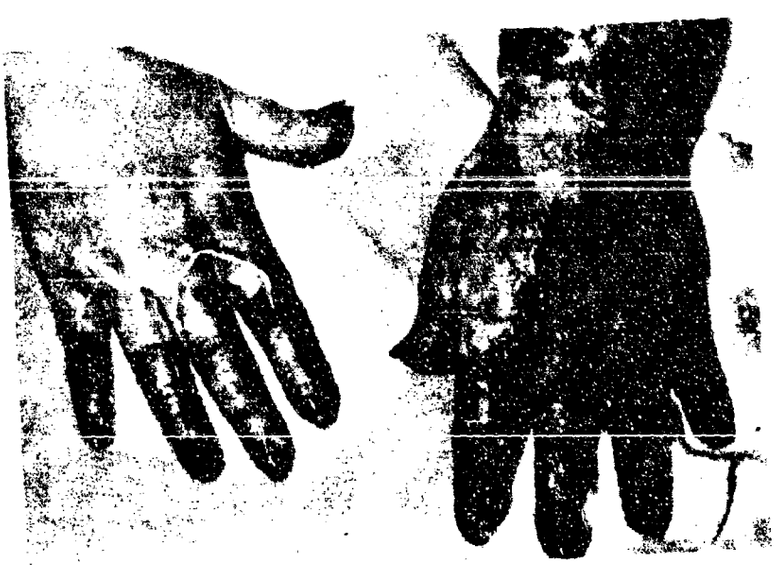
Day After Burn	Hematocrit %	Hemoglobin gm./100 ml.	Red Blood Cells million per cu.mm.	White Blood Cells thousand per cu.mm.	Neutrophile %	Lymphocyte %	Monocyte %	Basophile %	Eosinophile %	Reticulocytes %
(1)	20									
(2)	17									
(3)	18	5.0	1.82	23.5	94	6				
(4)	23									
(5)	22									
(6)										
(7)	20	10.5	2.82	23.5	85	14			1	1
(8)										
(9)	25	12.0		16.9	87	10			3	3
(10)										
(11)	29	12.5	3.43	16.8	93	7				
(12)										
(13)	32	14.3	4.61	18.8	77	19	2		2	2
(14)	33	14.0	4.68	16.3	82	18				
(18)	30	13.0	4.14	11.4	68	30		1	1	
(19)										
(20)	33	13.0	4.26	8.8	72	25	2		1	
(21)										
(22)	33	13.5	4.27	6.65	74	26			1	

Case No. 4-1945 (S.H.)

This 38 year old white woman received a 15% burn of the upper back, both hands and the left arm. All areas were second degree save for a few spots on the dorsum of the left hand. The patient showed no evidence of shock. There was moderate edema of the burned areas on the day after the burn. This edema began to subside about thirty-six hours after the injury, and coincidentally with this the patient showed a rise in temperature to around 101°F. Her temperature fluctuated for the first seven days following the burn, rising to 102.5°F. on the eighth day. Sulfadiazine was started at this time, and penicillin administration was stopped on the ninth day. The fever slowly subsided during the next five days. Output of urinary nitrogen and electrolytes did not vary grossly from normal. Urinary phosphate output was somewhat decreased.

It was necessary to apply small split thickness grafts to the dorsum of the left hand. These areas have healed well.

CASE No. 4-1945-(S.H.)



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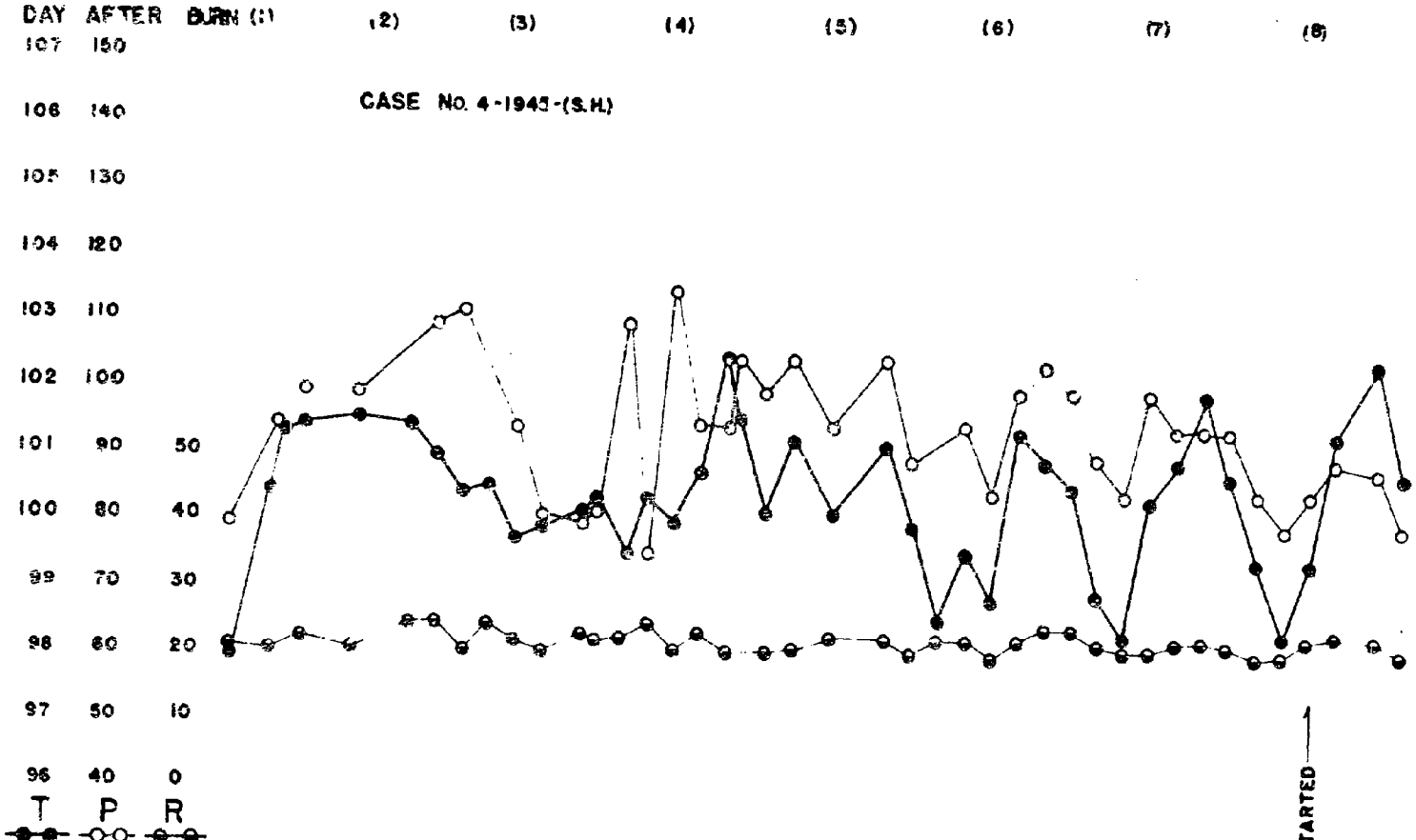
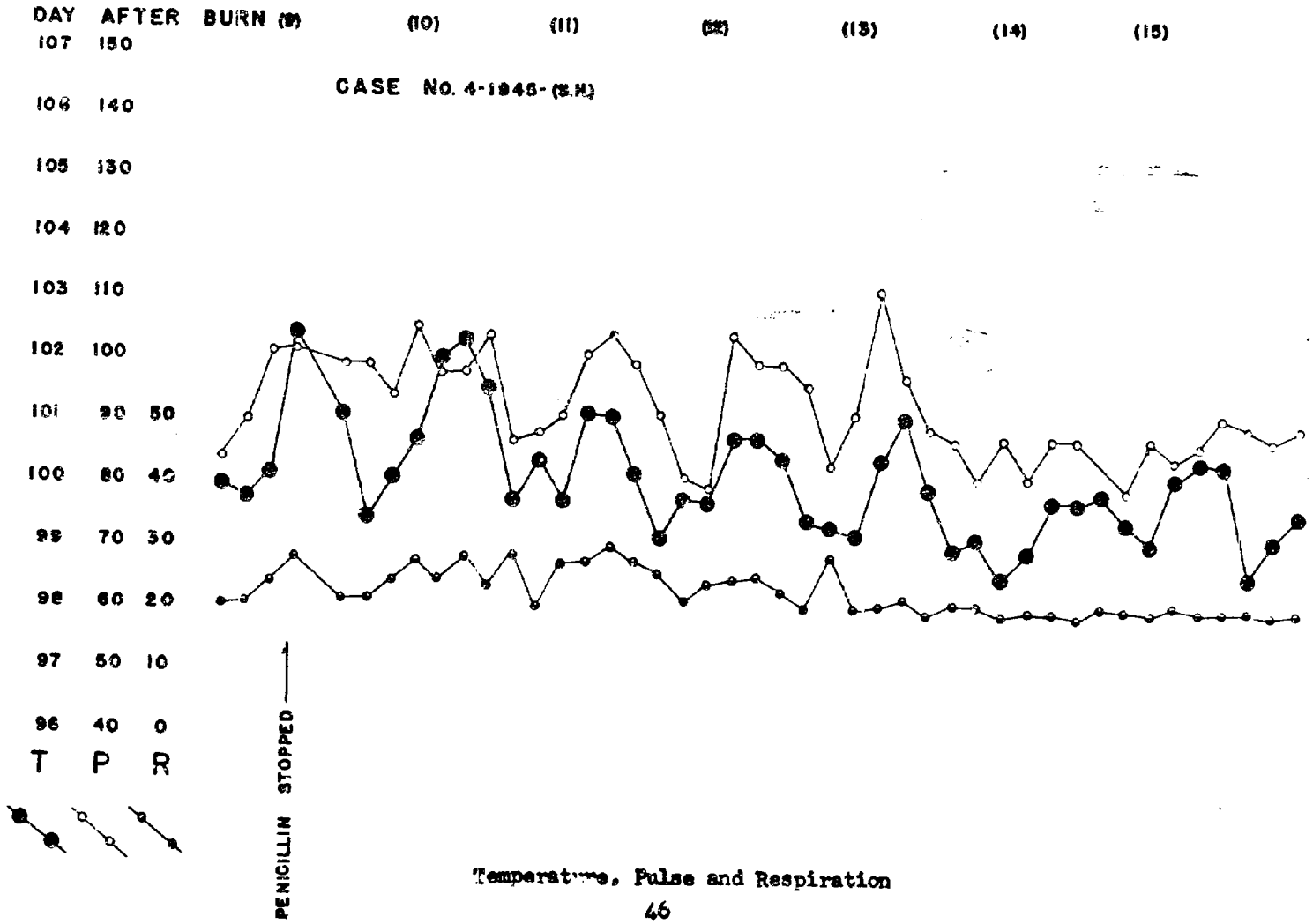


Temperature, Pulse and Respiration



Temperature, Pulse and Respiration

URINARY ELECTROLYTE CONTENT

(24 hour output given as grams and equivalents)

Case No. 4-1945 (S.H.)

Day After Burn	24 hr. Vol. ml.	Sodium		Potassium		Chloride		Phosphate	
		gm.	Eq.	gm.	Eq.	gm.	Eq.	gm.	Eq.
(2)	1500	2.44	0.161	1.91	0.049	4.08	0.114	0.68	0.011
(3)	2000	1.05	0.045	1.90	0.049	2.44	0.069	1.23	0.019
(4)	2200	1.32	0.057	2.37	0.061	0.20	0.005	0.45	0.007
(5)	1930	2.03	0.088	3.67	0.094	3.86	0.109	2.21	0.035
(6)	2045	2.31	0.105	2.69	0.069	4.15	0.117	0.62	0.010
(7)	3470	2.74	0.119	4.08	0.104	5.69	0.161	2.19	0.035
(8)	3830	3.89	0.170	3.74	0.096	4.90	0.138	2.42	0.038
(9)	4170	1.46	0.064	2.49	0.064	2.50	0.071	1.35	0.021
(10)	3860	2.32	0.101	2.22	0.057	3.16	0.089	1.81	0.029
(11)	2470	1.98	0.086	1.85	0.047	3.16	0.089	1.29	0.020
(12)	2080	2.34	0.102	1.41	0.036	2.70	0.076	1.02	0.016
(13)	2580	3.23	0.140	1.68	0.043	4.70	0.135	1.12	0.018
(14)	1940	2.52	0.109	1.50	0.038	3.38	0.095	1.53	0.024
(15)	2260	3.62	0.157	2.15	0.055	4.39	0.124	1.43	0.023
(16)	2550	4.15	0.180	2.04	0.052	6.23	0.175	2.30	0.036
(17)	1525	1.45	0.063	1.14	0.029	2.35	0.066	1.17	0.018
(18)	1310	2.16	0.094	1.21	0.031	2.75	0.078	1.33	0.021
(19)	3780	3.02	0.131	2.55	0.065	5.03	0.141	1.45	0.023
(20)	2640	3.69	0.160	1.85	0.047	5.70	0.161	1.39	0.022
(21)	900	0.47	0.026	0.73	0.019	0.80	0.023	0.29	0.005
(22)	1850	2.27	0.099	1.57	0.040	3.26	0.092	1.18	0.019

URINARY NITROGEN CONTENT

Case No. 4-1945 (S.H.)

Day After Burn	24 Hour Volume in ml.	Non-Protein Nitrogen gm./24 hr.	Urea Nitrogen gm./24 hr.
(1)			
(2)	1500	4.03	3.57
(3)	2000	3.90	3.30
(4)	2200	4.84	3.89
(5)	1930	7.10	3.82
(6)	2045	10.00	9.73
(7)	3470	8.90	7.43
(8)	3830	8.88	6.55
(9)	4170	8.12	7.62
(10)	3860	9.88	7.07
(11)	2470	8.40	6.33
(12)	2080	6.34	3.81
(13)	2580	6.97	5.33
(14)	1940	5.80	3.78
(15)	2260	4.98	2.62
(16)	2550	3.11	0.61
(17)	1325	4.65	1.75
(18)	1310	4.85	4.08
(19)	3780	7.37	7.14
(20)	2640	5.81	4.20
(21)	900	1.10	0.91
(22)	1850	5.40	3.39

HAEMATOLOGY

Case No. 4-1945 (S.H.)

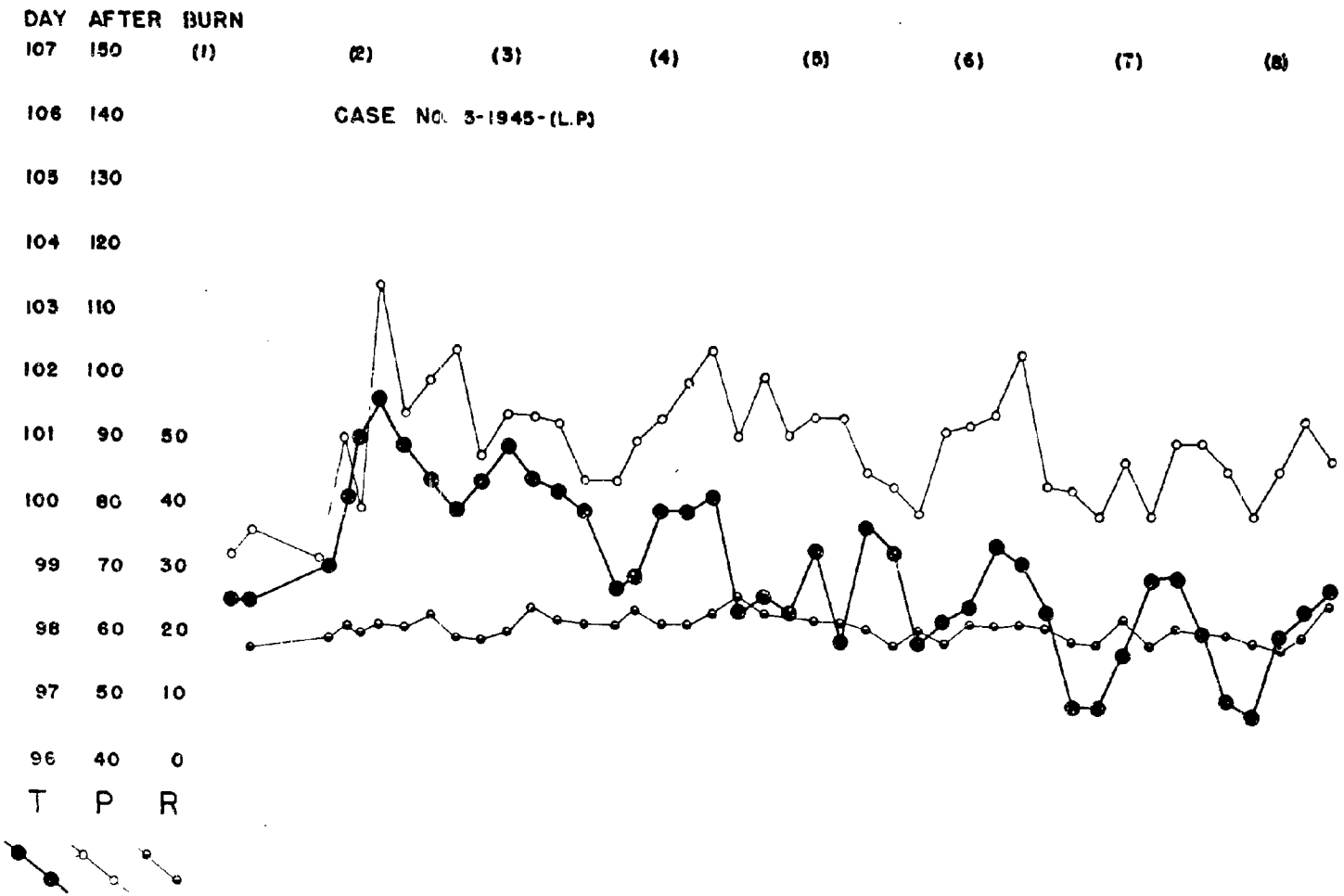
Day After Burn	Hemat-crit %	Hemo-globin gm./ 100 ml.	Red Blood Cells million per cu.mm.	White Blood Cells thou-sand per cu.mm.	Neut-rophile %	Lymph-ocyte %	Mono-cyte %	Baso-phile %	Eosin-ophile %	Retic-ulocytes %
(1)	40									
(2)	37									
(3)	34	16.5	4.20	25.1	75	10	14		1	
(4)										
(5)										
(6)										
(7)	37	14.5		9.6	77	22			1	
(8)										
(9)	38	15.0		9.1	82	15	1		2	
(10)										
(11)	38	17.0	4.54	8.6	83	11			6	
(12)										
(13)			4.56	11.5	73	23	2		2	
(14)										
(15)	36	15.0	4.50	9.0	67	33				
(16)										
(17)										
(18)		16.5	4.66	8.6	62	36			2	
(19)										
(20)	35	15.0	4.38	6.8	74	26				
(21)										
(22)		13.0	4.54	6.2	73	19		1	2	

Case No. 5-1945 (L.P.)

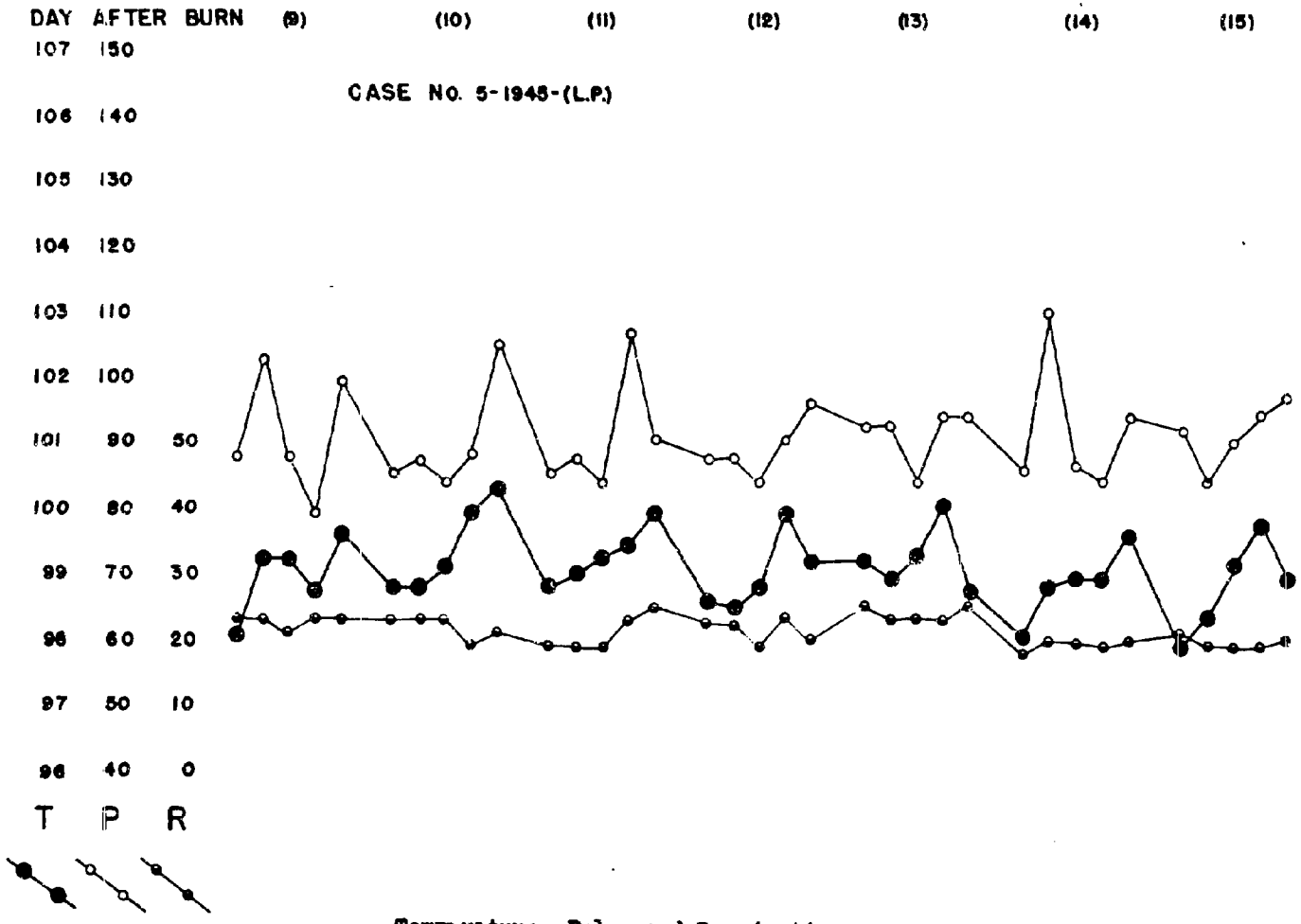
This 42 year old white woman sustained a 10% burn (4% third degree) of the right shoulder, arm and hand, as well as small spot burns of both ankles and legs. She developed quite marked edema of the face and right arm 18 hours after the injury. This subsided starting thirty-six hours after the injury and coincidentally with this the temperature rose to 101°F. The fever subsided gradually over the next four days. She showed no evidence of shock. The small spot burns of the right hand and ankles required the application of skin grafts.

CASE No. 5-1945-(L.P.)

CASE No.5-1945-(L.P.)



Temperature, Pulse and Respiration



Temperature, Pulse and Respiration

Case No. 6-1945 (R.M.)

This 23 year old colored girl received spot third degree burns of the right forearm and both knees. The burns were not over one and one-half inches in diameter but were third degree in depth and required application of skin grafts. This patient also complained of respiratory embarrassment consequent to the inhalation of smoke. This aspect of her case is discussed in more detail in the section on pulmonary casualties.

CASE No. 6-1945-(R.M.)

Case No. 7-1945 (A.F.)

This 30 year old colored woman sustained 5% burns (4% third degree) of the right hand, left elbow and right breast. All three areas were small in extent but deep and required the application of skin grafts.

CASE No. 7-1945-(A.F.)

CASE No. 7-1945-(A.F.)

Case No. 8-1945 (M.S.)

This 30 year old colored woman received a 7% burn (3% third degree) of the left arm and hand, left breast and left side of the face. The burns of the breast and fingers required application of skin grafts.

CASE No. 8-1945-(M.S.)

Case No. 9-1945 (M.N.)

This 48 year old white woman received a second degree burn of the right hand and arm. No skin grafts were required.

CASE No. 9-1945-(M.N.)

Case No. 10-1945 (S.J.)

This 50 year old colored woman received an 8% burn (3% third degree) of the left arm and shoulder and left side of the face. An area four by four centimeters on the external aspect of the left elbow required application of skin grafts.

This woman was a luetic with a four plus Kahn reaction. She showed no evidence of leutic lesions on physical examination and her burned areas healed quite rapidly.

CASE No. 10-1945-(S.J.)

CASE No. 10-1945-(S.J.)

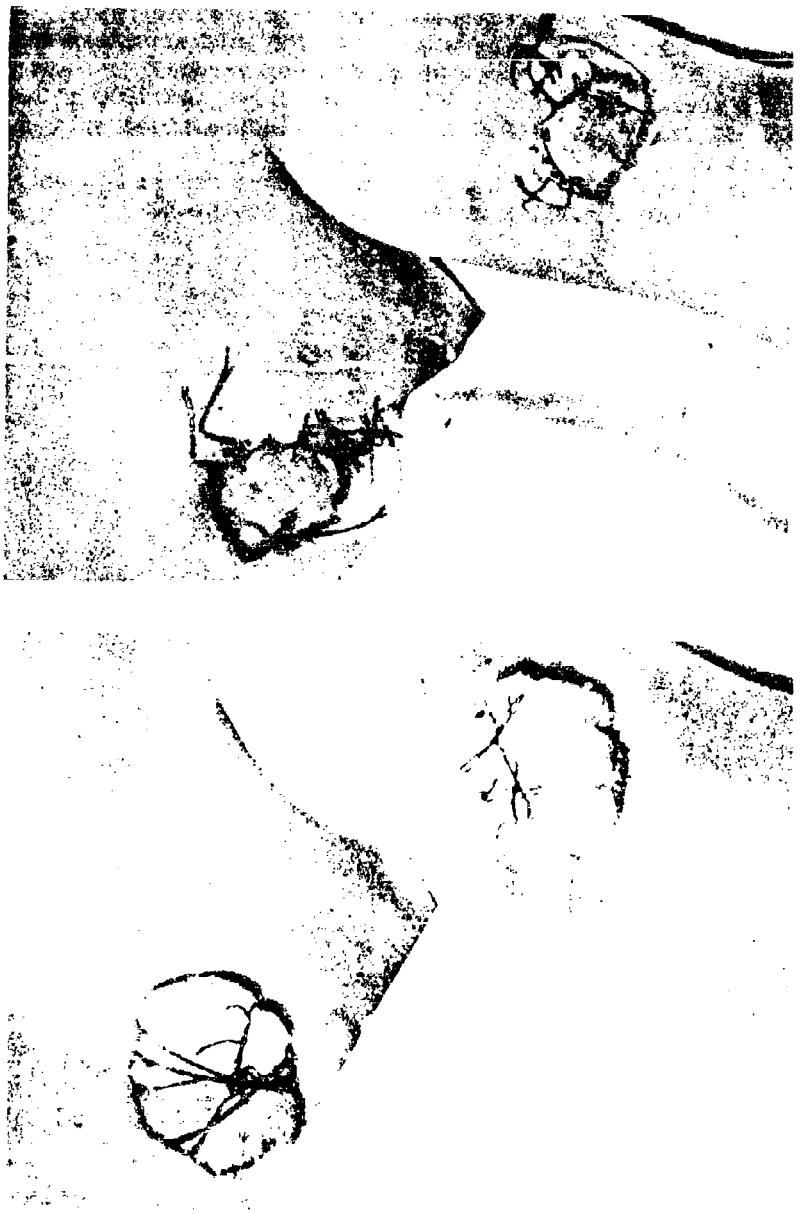
Case No. 11-1945 (G.Z.)

This 58 year old white man received a 6% burn (1% third degree) on the top of his head and a spot in the inter-scapular region of the back. Only the burn on the back required application of skin grafts.

This man was afflicted with idiopathic epilepsy. He was very allergic to all barbiturates and could only be controlled on bromides. As a result of the tendency towards pyodermia some difficulty was encountered in getting skin grafts to heal, but a good end result was obtained.

Case No. 13-1945 (K.C.)

This 19 year old white girl received an 8% burn (2% third degree) involving both arms and a small spot on the back. A small area on the back and on the back of the right arm required application of skin grafts.



CASE No.13-1945-(K.C.)

Case No. 16-1945 (C.P.)

This 44 year old white woman received burns covering 50% (45% third degree) of her body surface, involving the body, both arms and the right leg. In addition to the burns, she had a deep laceration of the right side of the neck and deep lacerations of the right forearm with herniation of the muscles from the wound. Within an hour after the injury she entered a state of shock which did not respond to therapy. In spite of the administration of 2500 ml. of plasma and 2000 ml. of saline, her pulse did not fall below 140. The extremeties remained cold with light purple mottling of the skin. She remained mentally clear, although restless, for nine hours. She then became comatose and died with arrest of respiration ten and one-half hours after the accident.

Case No. 17-1945 (C.C.)

This 28 year old colored girl received a burn involving about 65% (50-60% third degree) of the body. The areas involved were both arms, trunk, and one leg. The burned areas on the left side of the body were so deep that the bones were exposed, and the fingers of the left hand were completely burned away. This patient died three hours after being injured, in deep shock, in spite of the administration of plasma.

Case No. 30-1945 (V.H.)

This 34 year old colored woman received a 40% burn (35% third degree) involving face and arms, front of the chest and the left thigh and hip. She had had a 15% WP burn of the left hip and thigh about two years previously. She showed no signs of severe shock but was given 2000 ml. of plasma as well as saline solution during the first ten hours after the burn. Her pulse remained below 102 per min. She put out about 600 ml. of urine in the nineteen hours following injury, and urinanalysis revealed no striking abnormalities. She remained oriented mentally but became somewhat drowsy during the last ten hours of life.

The plasma non-protein nitrogen rose to 120 mg.% six hours after the burn and was 370 mg. 18 hours after the burn. The blood urea nitrogen at this time was 22 mg.% and the alpha amino nitrogen 6 mg.%. The patient was completely rational and cooperative at this time. She had 1.6% methemoglobin in the whole blood 15 hours after injury. There was no evidence of massive hemolysis in the plasma. The plasma chlorides and sodium were somewhat low (85 mEq. and 120 mEq., respectively).

Fifteen minutes before death, the patient suddenly passed into coma. Respiratory action ceased suddenly in the inspiratory position.

Post-mortem examination grossly showed a liver somewhat tawny in color. The kidneys were flabby but normal in color. The brain showed moderate edema. The remainder of the findings were normal.

Microscopically:

Lungs: Considerable patchy alveolar edema with moderate capillary hyperemia, moderate edema of the perivascular and interlobular connective tissue. There were scattered macrophages within the alveoli. The bronchi and bronchioles showed no significant changes. A section of the trachea showed extensive desquamation of the lining epithelium with moderate submucosal congestion and infiltration with a moderate number of lymphocytes, plasma cells and a few polymorphonuclear neutrophiles.

Heart: One section from the interventricular septum showed a limited area of myocardial fibrosis at the apex. Other sections showed no lesions and the arteries were normal.

Spleen: Marked congestion but otherwise normal.

Liver: Scattered throughout all sections were numerous areas of focal necrobiosis, one or two in each lobule, averaging one eighth to one quarter millimeter in diameter, fairly well demarcated, and chiefly midzonal in location. The cells in these foci had an eosinophilic or hyalin-staining cytoplasm, with pyknotic or karyolytic, occasionally karyorrhectic nuclei. There was no reactive inflammation. Most of the necrotic cells were still in situ, but disintegration was beginning to take place. The remaining parenchyma and bile ducts were normal.

Kidneys: There was marked cloudy swelling of the tubular epithelium, especially of the proximal convoluted tubules, with fraying of cell borders and granular material, as well as desquamated cells in the tubular

lumina. The distal and collecting tubules contained many protein casts and a few hemoglobin casts. The glomeruli showed no change.

Adrenals: Normal.

G. I. Tract: Normal.

Brain: No significant histological changes.

CASE No. 30-

-1945-(V.H.)

CASE No.30-

-1945-(V.H.)

CASE No.30-1945-(V.H.)

Case No. 31-1945 (W.M.W.)

This 19 year old colored girl received a 15% burn (8% third degree) involving both arms, an area of the right side of the trunk and an area on the lateral aspect of the right thigh. She showed no evidence of shock, but was given 500 ml. of plasma and 1500 ml. of saline solution intravenously in the first four hours after the burn. Because of difficulty in voiding she was catheterized 19 hours after the burn, and 1200 ml. of clear urine were obtained. As she had not voided 3 hours later she was again catheterized, and at this time 400 ml. of dark bloody urine were obtained (22 hours after injury). The urine contained no red blood cells or casts, but the hemoglobin content was about 0.1 gm. per 100 ml. A blood sample drawn at this time showed massive intravascular hemolysis was occurring. Carbon dioxide content of the serum was 43 vols. % and the whole blood hemoglobin was 13.5 gm. She was given intravenous sixth molar sodium lactate to build up her alkali reserve. The hemolytic reaction continued for eighty-eight hours. Urine hemoglobin output rose to 16 gm. at 96 hours after the burn, 21 gm. at 120 hours, and 24 gm. at 144 hours. At 72 hours after the burn the hemolysis had reduced the blood hemoglobin to 5.0 gm. and transfusions were started. Whole blood methemoglobin reached 6.4 % at 96 hours but decreased sharply thereafter. As can be seen from the accompanying graph (Appendix III), the major part of the methemoglobin was extracellular during the first two days of hemolysis. The hemolysis apparently stopped sharply about 108 hours after injury (thus lasting 88 hr.). A specimen of urine at 108 hours contained hemoglobin in large quantities, while a specimen at 109 hours, was clear yellow and contained only a trace of hemoglobin.

After the infusion of an additional 3000 ml. of whole blood the patient was able to maintain her own hemoglobin level. Quantitative bromsulfalein test showed no evidence of liver damage the day after cessation of hemolysis. Para-amino hippuric acid clearance was also normal, indicating the absence of any marked grade of renal damage.

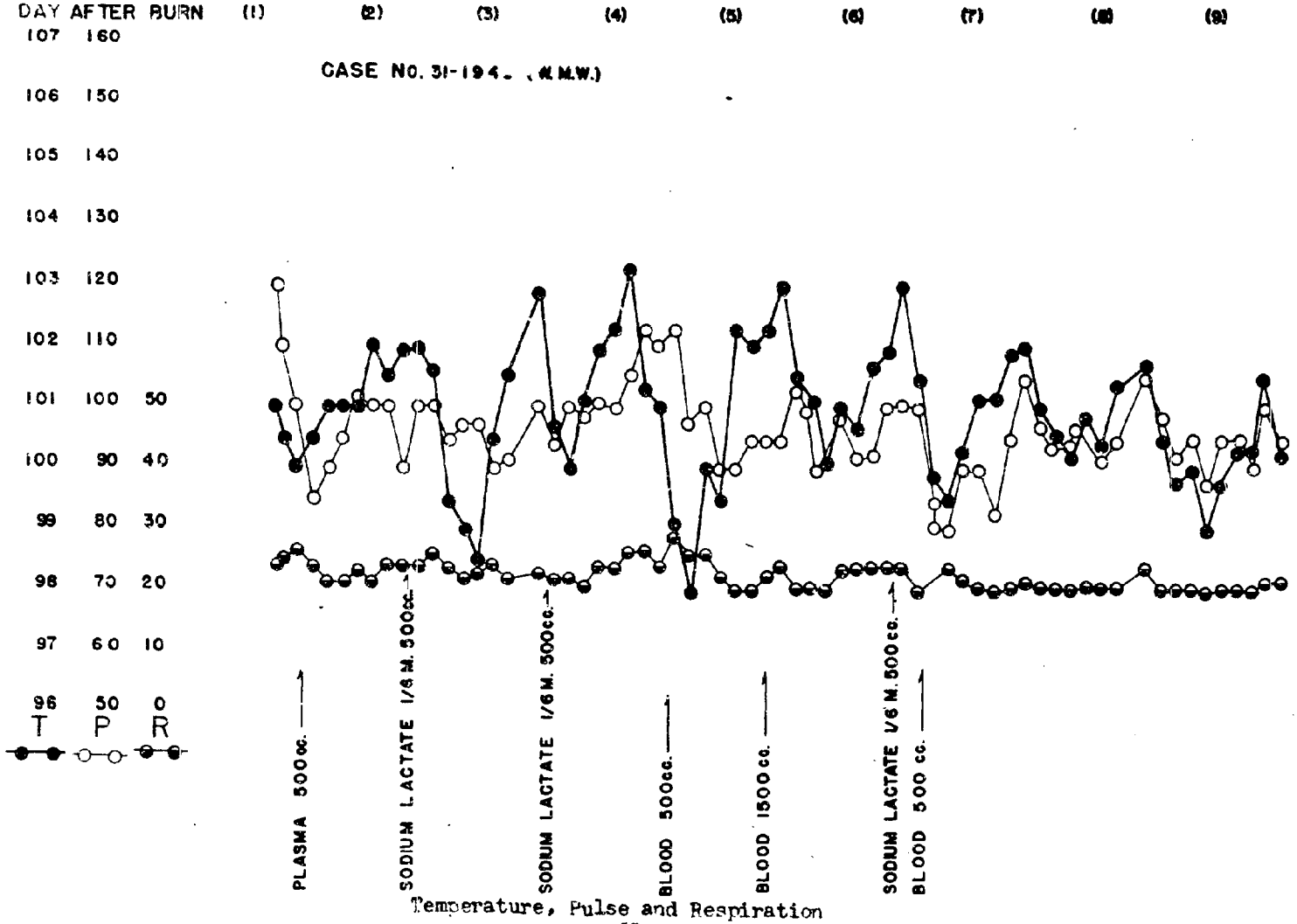
During the period of hemolysis the plasma non-protein nitrogen rose sharply, reaching 290 mg.% 100 hours after the burn. Coincidentally, there was a marked increase in alpha amino nitrogen from a normal of 6.0 mg.% to 64 mg.%. Urea nitrogen was only moderately increased, reaching a high level of 28 mg.%.

There was some slight increase in fragility of red blood cells for three days after the burn, but thereafter the fragility was found to be normal. After equilibration of the patient's blood with 100% carbon dioxide for six hours, it was possible to demonstrate sickling of the red blood cells. Tests for auto-hemolysins and agglutinins, as well as for agglutinins and hemolysins in the plasma given the first day, proved negative.

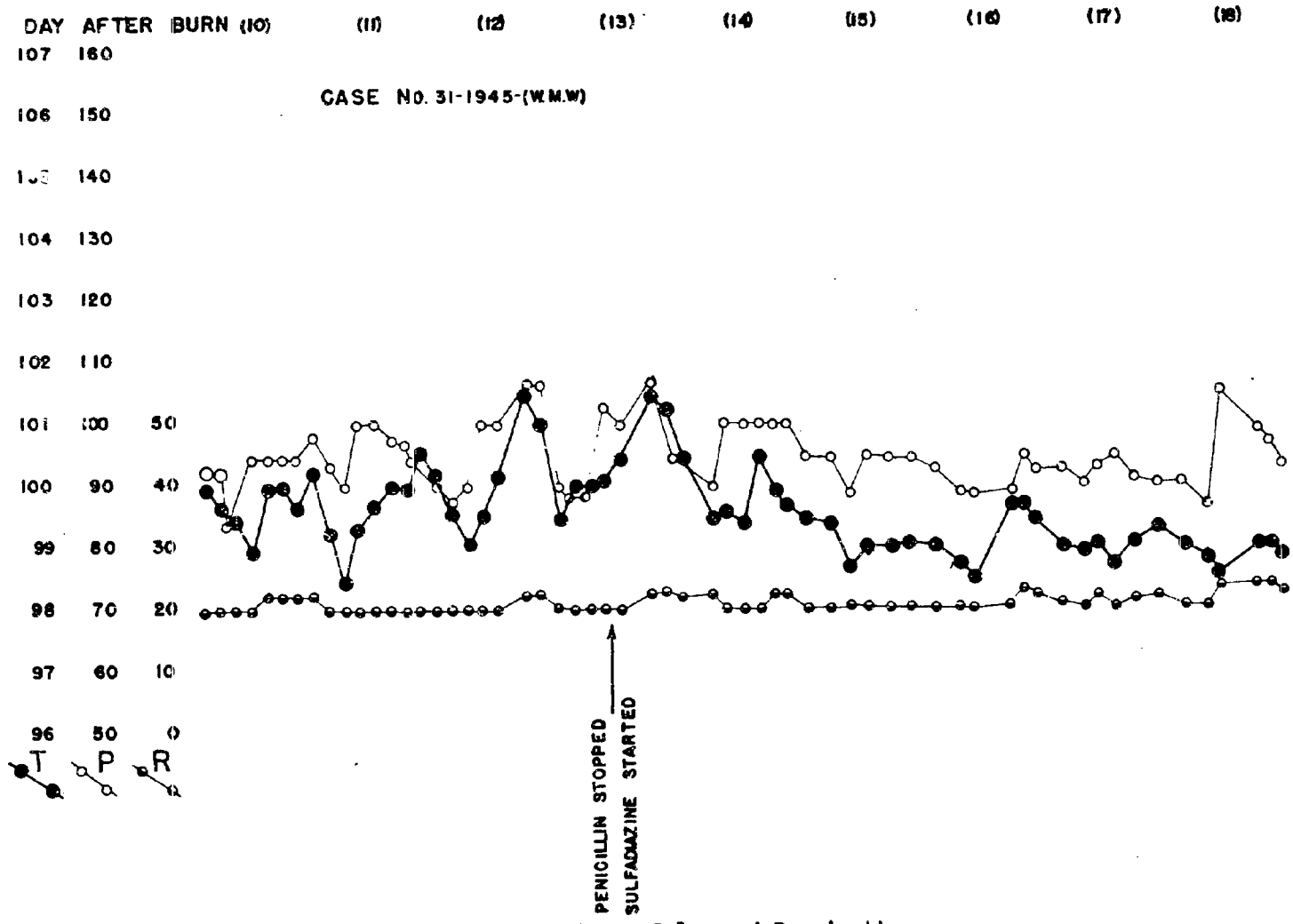
The finding of the sickle cell trait is thus the only abnormal hematological finding. A detailed history from the patient and her mother revealed no previous episodes of hemolysis or any illness identifiable as a sickle cell crisis. The period of hemolysis reported here was not typical of sickle cell crisis in that there were few, if any, systemic manifestations seen. There was no swelling of joints, chill or high fever. There is a possibility that there may be some connection between the sludging of red cells in the peripheral capillaries following a burn and the sickle cell trait in producing hemolysis seen here, but there is no positive evidence for this.

CASE No. 31-1945-(W.M.V.)

CASE No. 31-1945-(W.M.W.)



Temperature, Pulse and Respiration



Temperature, Pulse and Respiration

PLASMA ELECTROLYTES

Case No. 31-1945 (W.M.W.)

Day After Burn	Sodium		Potassium		Chloride		CO_2	
	mg./ 100 ml.	mEq./ liter	mg./ 100 ml.	mEq./ liter	mg./ 100 ml.	mEq./ liter	Vols. %	mEq./ liter
(1)								
(2)	350	152	13.0	3.3	367	103	48	20.8
(3)	299	130	22.0	5.6	284	80	58	25.2
(4)	276	120	24.0	6.2	301	85	62	26.9
(5)	295	128	19.0	4.9	266	75	55	23.9
(6)	290	126	14.0	3.6	231	65	60	26.0
(7)	299	130			319	90	59	25.6
(8)	294	128	13.5	3.5	334	94	61	26.7
(9)	310	135			326	92		
(10)	326	142	13.0	3.3	341	96	65	28.2
(11)					344	97		
(12)	340	148	12.5	3.2	319	100	62	26.9
(13)					359	101		
(14)	333	145					64	28.2
(15)	340	148	19.5	5.0				

PLASMA NITROGEN CONTENT

Case No. 31-1945 (W.M.W.)

Day After Burn	Protein gm./ 100 ml.	Non-Protein Nitrogen mg./ 100 ml.	Urea Nitrogen mg./ 100 ml.	Alpha Amino Nitrogen mg./ 100 ml.
(1)	7.0		13.0	7.0
(2)	7.0	50 (0800) 120 (1900)	15.0	22.0
(3)	6.8	230	15.0	48.3
(4)	6.7	270	26.0	64.3
(5)	6.9	290	28.0	50.0
(6)	7.0	75	19.0	12.0
(7)		35	15.0	7.0
(8)	6.5	40		
(9)		45	12.0	6.0
(10)	6.5	43		
(11)		38	14.0	7.0
(12)		35		
(13)	6.8	32	11.0	7.5
(14)		30		

URINARY ELECTROLYTE CONTENT

(24 hour output given as grams and equivalents)

Case No. 31-1945 (W.M.W.)

Day After Burn	24 hr. Vol. ml.	Sodium		Potassium		Chloride		Phosphate	
		gm.	Eq.	gm.	Eq.	gm.	Eq.	gm.	Eq.
(1)	1175	3.41	0.148	4.13	0.106	5.03	0.142	0.91	0.014
(2)	1408	1.41	0.061	0.88	0.025	2.65	0.075	0.79	0.013
(3)	2875	3.73	0.162	1.65	0.042	6.03	0.170	1.28	0.020
(4)	4430	9.10	0.396	1.22	0.031	12.30	0.347	2.00	0.031
(5)	3655	8.58	0.373	3.36	0.086	12.00	0.338	0.95	0.015
(6)	3000	5.25	0.228	0.90	0.023	9.00	0.[illegible]	1.11	0.018
(7)	1700	1.79	0.078	0.43	0.011	3.23	0.091	0.81	0.013
(8)	3000	3.15	0.137	0.60	0.015	4.83	0.136	0.66	0.010
(9)	2700	3.11	0.135	0.68	0.017	5.05	0.142	0.73	0.012
(10)	2015	2.42	0.105	0.66	0.017	4.19	0.118	1.73	0.014
(11)	2015	2.42	0.105	0.66	0.017	4.19	0.118	1.73	0.014
(12)	3930	5.69	0.248	1.30	0.033	10.62	0.299	2.11	0.033
(13)	3400	5.62	0.245	3.57	0.091	10.69	0.301	3.28	0.052
(14)	1250	1.94	0.084	0.91	0.023	2.75	0.077	1.04	0.016
(15)	1800	3.96	0.172	2.83	0.072	3.66	0.103	0.67	0.011
(16)	1800	3.96	0.172	2.83	0.072	3.66	0.103	0.67	0.011
(17)	2000	2.50	0.109	2.80	0.071	3.96	0.111	1.96	0.031
(18)	2000	2.50	0.109	2.80	0.071	3.96	0.111	1.96	0.031
(19)	1385	1.80	0.078	1.32	0.034	3.02	0.085	1.16	0.018
(20)	2000	3.80	0.160	2.40	0.062	5.86	0.160	1.85	0.029
(21)	2000	3.80	0.160	2.40	0.062	5.86	0.160	1.85	0.029
(22)	1605	1.85	0.080	1.85	0.047	2.73	0.077	1.50	0.015
(23)	1605	1.85	0.080	1.85	0.047	2.73	0.077	1.37	0.020
(24)	1610	2.25	0.098	2.09	0.054	2.69	0.076	1.37	0.020
(25)	1860	1.03	0.045	1.58	0.040	1.53	0.043	1.37	0.020
(26)	2130	2.88	0.125	2.56	0.065	4.05	0.114	1.20	0.019
(27)	1340	2.18	0.095	1.91	0.049	3.78	0.107	0.70	0.011

URINARY NITROGEN CONTENT

Case No. 31-1946 (W.M.W.)

Day After Burn	24 Hour Volume in ml.	Non-Protein Nitrogen gm./24 hr.	Urea Nitrogen gm./24 hr.
(1)	1175	12.1	8.24
(2)	1408	7.04	6.57
(3)	2875	11.23	8.08
(4)	4430	15.07	11.08
(5)	3655	12.62	10.45
(6)	3000	9.15	7.86
(7)	1700	8.69	8.50
(8)	3000	8.10	8.05
(9)	2700	8.58	8.23
(10)	4030		12.31
(11)			
(12)	3930		16.31
(13)	3400	13.26	11.62
(14)	1250	9.00	7.80
(15)	1800	8.55	7.30
(16)	1800	8.55	7.30
(17)	2000	10.00	7.88
(18)	2000	10.00	7.88
(19)	1385	5.75	4.31
(20)	2000	8.3	8.00
(21)	2000	8.3	8.00
(22)	1605	4.69	3.91
(23)	1605	4.69	3.91
(24)	1610	8.44	7.31
(25)	1860	6.80	5.89
(26)	2130	7.54	6.10
(27)	1340	4.58	3.51
(28)	1910	5.12	4.66
(29)	2510	3.36	3.31
(30)	2623	4.02	4.18
(31)	2623	4.02	4.18
(32)	2320	6.62	5.22
(33)	1550	1.89	1.89
(34)	3350	6.93	5.97
(35)	780		2.56
(36)	2600		6.97
(37)	2210	7.28	4.19
(38)	2210	7.28	4.19
(39)	2280	4.70	4.18
(40)	2370	6.07	4.55

HEMATOLOGY

Case No. 31-1945 (W.M.W.)

Day After Burn	Hematocrit %	Hemoglobin gm./100 ml.	Red Blood Cells million per cu.mm	White Blood Cells thousand per cu.mm.	Neutrophile %	Lymphocyte %	Monocyte %	Basophile %	Eosinophile %	Reticulocytes %
(1)										
(2)	35	10.0	3.06	12.2	84	27				2.0
(3)	20	5.0	1.58	20.5	77	22	1			6.4
(4)	22	5.2	2.20	22.6	76	24				7.5
(5)	28	9.0	3.29	15.5	73	26	1			6.1
(6)	31	10.0	4.44	8.6	77	22			1	5.6
(7)	30	9.5	4.20	7.05	64	31			5	4.8
(8)	34	10.6	4.38	10.8	79	26			4	3.0
(9)	32	9.8	3.97	13.7	74	24			2	2.2
(10)	35	11.0	3.69	19.8	76	24				1.9
(11)	33	10.0	4.22	9.2						
(12)	33	10.8	4.04	7.1						
(13)		10.8	4.24	7.8						
(14)	34	11.0	3.62	5.8						
(15)		10.5	4.39	5.4						

EXTRACELLULAR AND INTRACELLULAR DISTRIBUTION OF HEMOGLOBIN AND METHEMOGLOBIN IN WHOLE BLOOD.

Case No. 31-1945 (W.M.W.)

Day After Burn	Cells			Plasma		
	Hemoglobin gm./100 ml.	Methemoglobin %	Methemoglobin gm./100 ml.	Hemoglobin gm./100 ml.	Methemoglobin %	Methemoglobin gm./100 ml.
(1)	13.5					
(2)	10.0	1.8	0.19	0.00	0.0	0.00
(3)	5.0	5.1	0.26	0.27	77.0	0.20
(4)	4.9	6.4	0.31	0.63	36.0	0.23
(5)	6.3	1.3	0.08	0.45	10.0	0.05
(6)	10.0	0.8	0.08	0.20	0.0	0.00
(7)	11.1	0.0	0.00	0.12	0.0	0.00
(8)	11.3	0.0	0.00	0.00	0.0	0.00

HEMOGLOBIN CONTENT OF URINE

Day After Burn	Time	Volume	Hemoglobin gm.	Hemoglobin gm. of nitrogen
(1)				
(2)	24 hr.	1408	2.0	0.33
(3)	24 hr.	2875	7.19	1.17
(4)	24 hr.	4430	16.4	2.68
(5)	24 hr.	3930	20.6	3.37
(6)	24 hr.	3000	24.3	3.97
(7)	24 hr.	1700	0.0	0.00

Case No. 32-1945 (S.M.)

This 28 year old white woman received a 5% burn (1% third degree). The burns were spatter burns of the hands and forearms. Only one small area three by four centimeters on the dorsum of the right hand required application of skin grafts.

Case No. 33-1945 (L.J.)

This 18 year old colored boy was standing in the direct path of the discharging PWP, about fifty feet from the rocket as it lay on the ground. He was enveloped in a cloud of burning material and stopped to brush the burning mass from his legs. He received a 25% burn (15% third degree) involving the anterior surface of both legs from mid-thigh downwards, both arms and the right side of his face and neck. He was given 1000 ml. of plasma as well as 1500 ml. of saline intravenously when he arrived at the hospital. He showed only moderately severe hemoconcentration.

He had a penile chancre of one week's duration which showed T. pallidum on darkfield examination. Penicillin dosage was increased to 40,000 units every third hour for seven days because of this finding.

He showed little or no systemic reaction until twenty-six hours after the accident at which time he began to show the mass hemolysis previously described in case No. 31-1945 (W.M.W.) His serum carbon-dioxide content at this time was 49 vols. %. He was given intravenous sixth molar sodium lactate in order to maintain his alkali reserve. Hemolysis lasted seventy-two hours and ceased suddenly as in the other case.

The blood methemoglobin reached 10.4% on the fourth day but dropped rapidly with cessation of hemolysis. The methemoglobin in this case was almost entirely intracellular. Hemoglobin excretion in the urine was slightly lower than in the other case, but reached 19.4 grams 90 hours after the burn. Para-amino hippuric acid clearance several days after cessation of hemolysis was normal. Quantitative bromsulphalein liver function test showed no abnormality.

Serum potassium reached a peak of 23.7 mg.% on the third day.

As in Case No. 31-1945, there was a very marked rise in plasma non-protein nitrogen, reaching 328 mg.% 36 hours after the burn. This was accompanied by a rise in the plasma alpha amino nitrogen reaching 74.4 mg.% on the 4th day while the urea nitrogen varied only slightly from normal. There was a very marked increase in urinary non-protein nitrogen paralleling blood destruction.

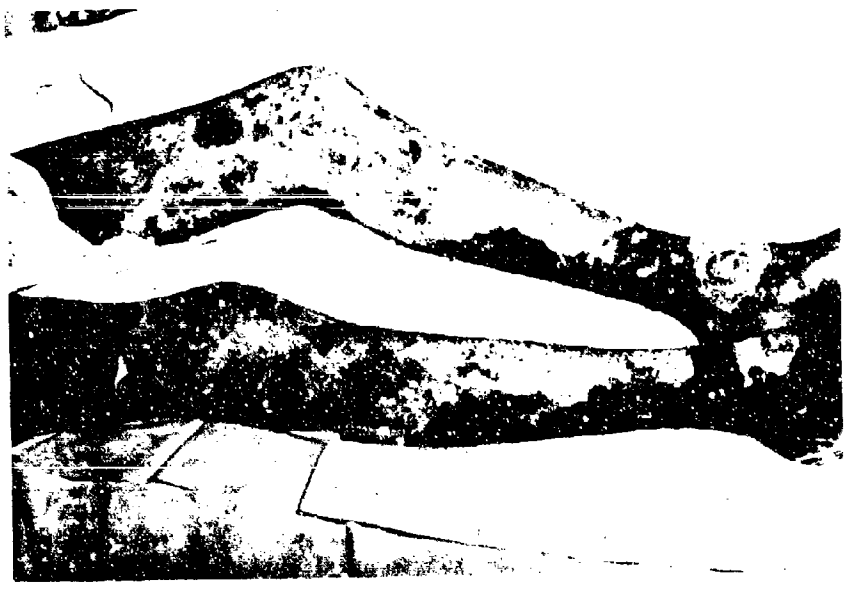
Serum bilirubin reached 34 mgm.% 104 hours after the burn and dropped to normal by the tenth day. Urinary urobilinogen excretion paralleled this change.

Hematological investigation revealed a rather marked sickling trait. The patient and his family both stated that he had never been ill up to the date of injury. The remainder of the hematological tests were negative as in Case No. 31-1945.

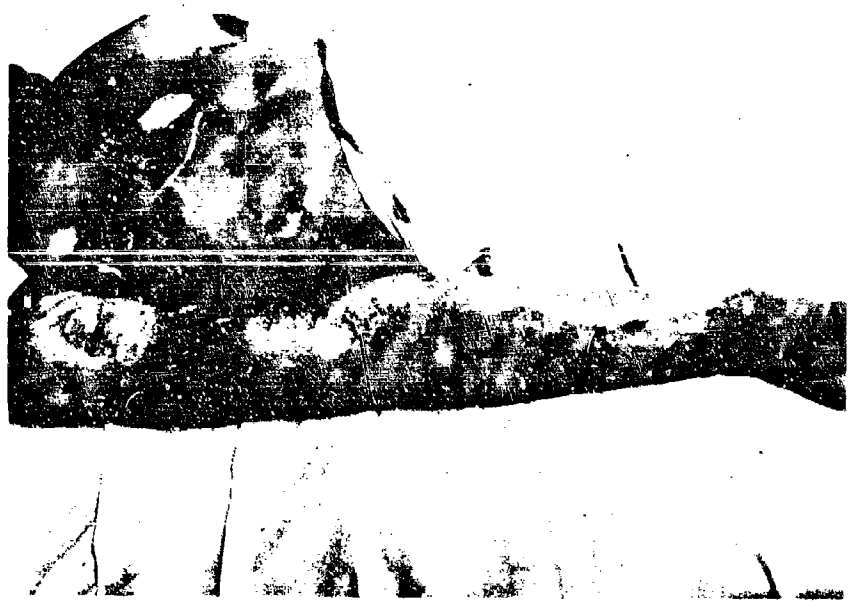
His temperature rose slowly to 104°F. over the first week after the burn. Sulfadiazine administration was started about 110 hours after the burn and the temperature returned to normal gradually over the next seven days. Penicillin administration was stopped on the tenth day.

The remainder of his clinical course has been uneventful. He is undergoing a series of multiple Padgett dermatome grafts to cover the granulating third degree areas.

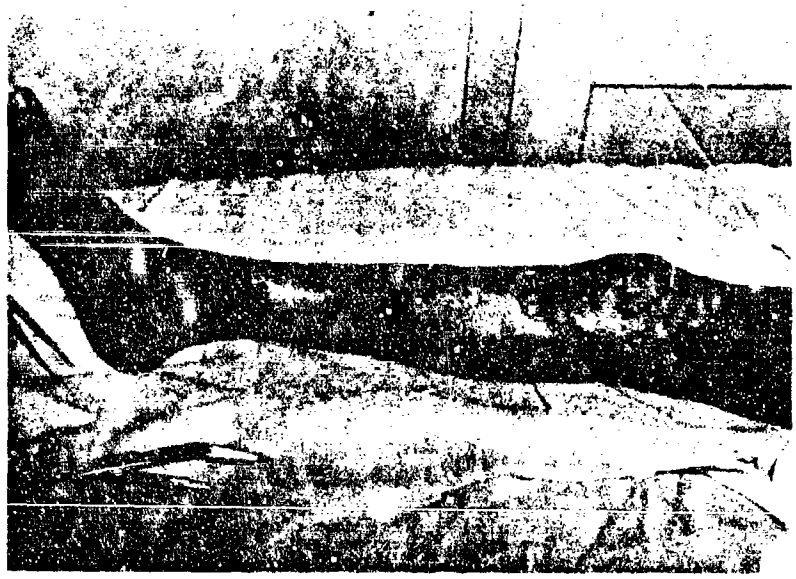
CASE No. 33-1945-(L.J.)

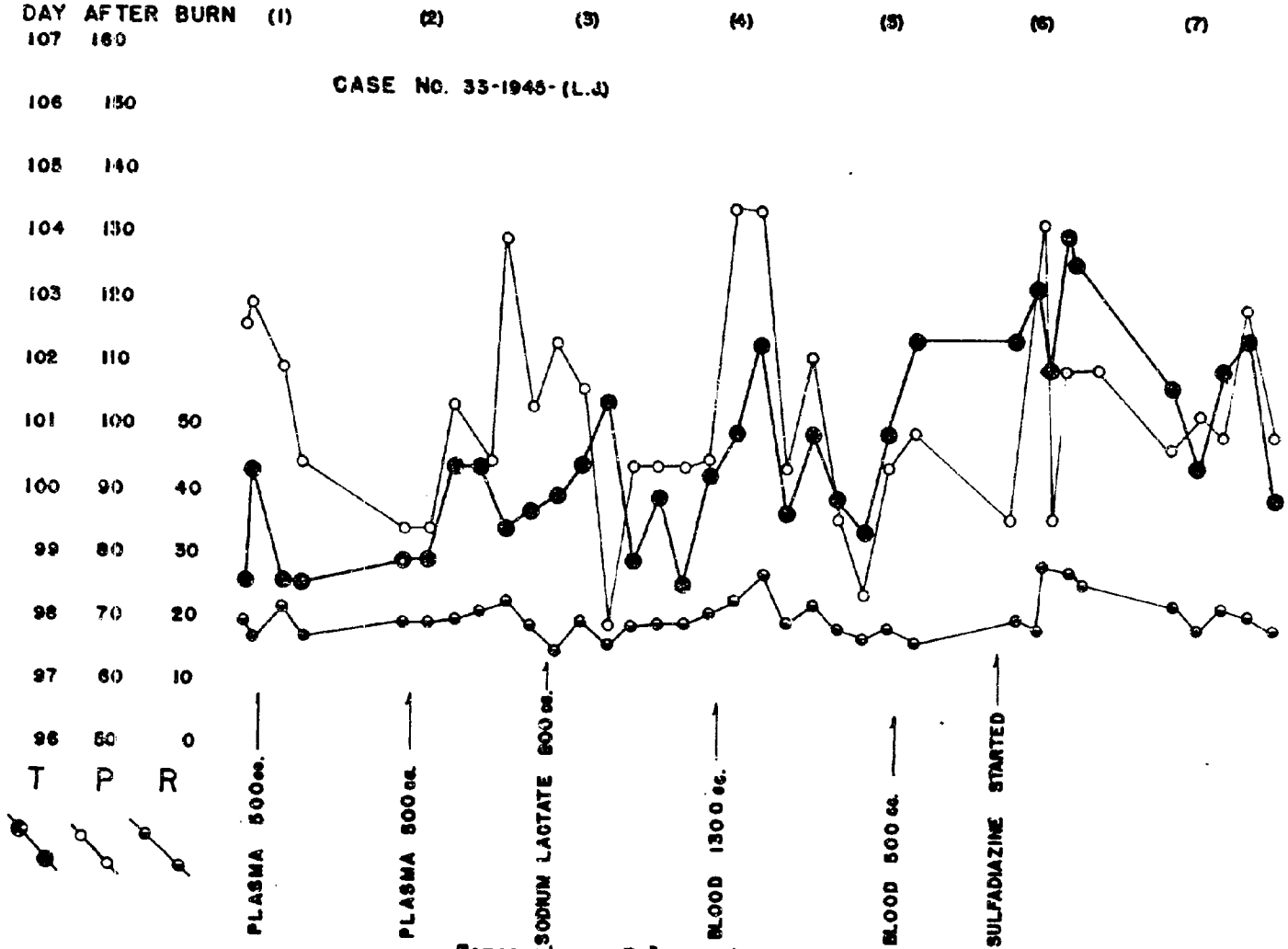


CASE No.33-1945-(L.J.)

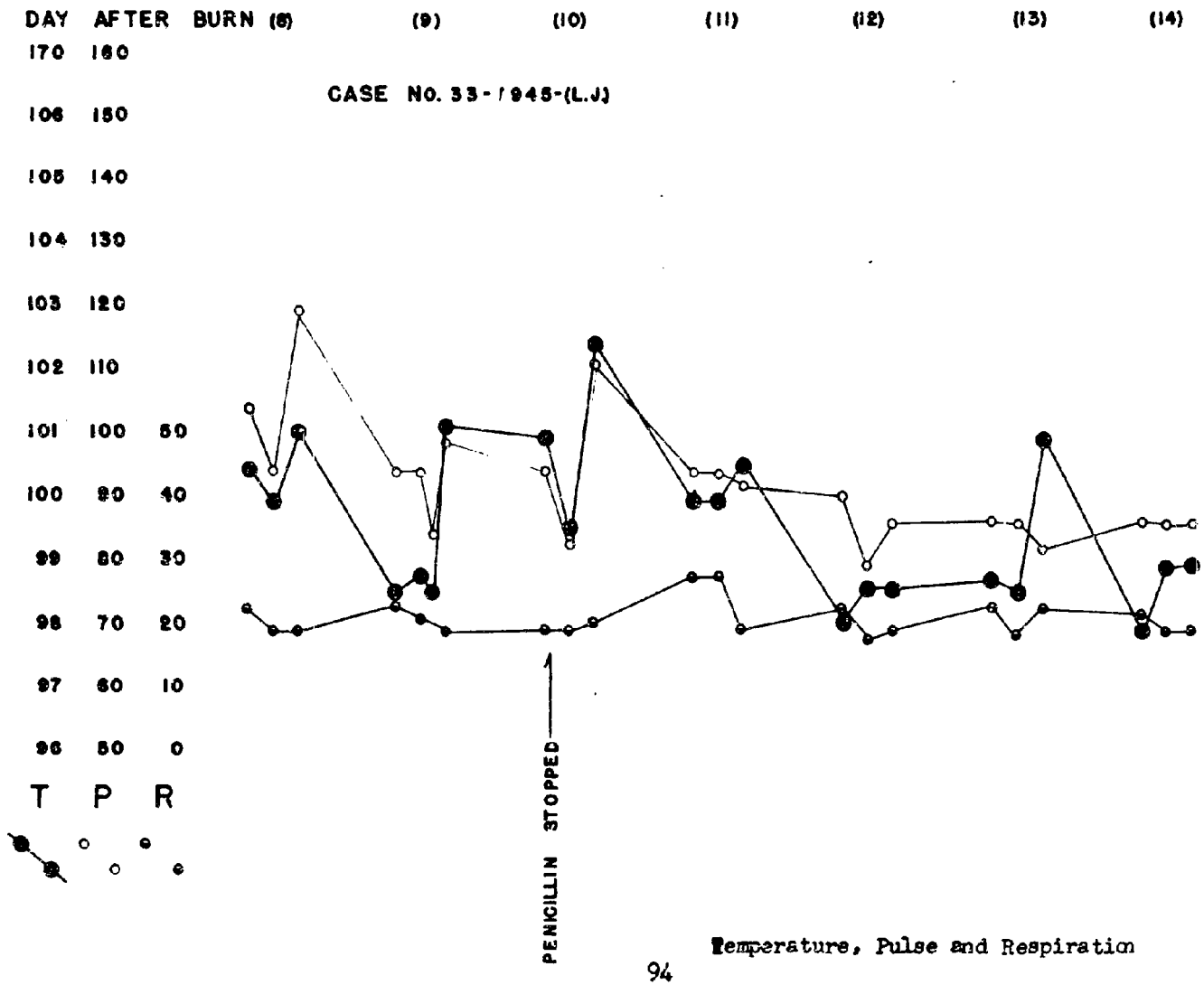


CASE No. 33-1945-(L.J.)





Temperature, Pulse and Respiration



Temperature, Pulse and Respiration

PLASMA ELECTROLYTES

Case No. 33-1945 (L.J.)

Day After Burn	Sodium		Potassium		Chloride		CO_2	
	mg./ 100 ml.	mEq./ liter	mg./ 100 ml.	mEq./ liter	mg./ 100 ml.	mEq./ liter	Vols %	mEq./ liter
(1)	340	148			350	98.6		
(2)	276	120	21.8	5.6	307	86	49	19.5
(3)	279	121	23.7	6.1	318	89	53	23.0
(4)	288	125	18.8	4.8	307	86	58	25.2
(5)	253	110	17.5	4.5	298	84	60	26.0
(6)	281	122	16.0	4.1	316	89	55	14.3
(7)	289	125			346	97	61	26.5
(8)	320	139	14.8	3.8	346	97		
(9)	253	135						
(10)	325	143	18.0	4.6	331	93		
(11)	361	135						
(12)	361	135			358	101	63	27.2
(13)								
(14)								
(15)	322	140	13.5	3.4	321	90	63	27.5

PLASMA NITROGEN CONTENT

Case No. 33-1945 (L.J.)

Day After Burn	Protein gm./ 100 ml.	Non-Protein Nitrogen mg./ 100 ml.	Urea Nitrogen mg./ 100 ml.	Alpha Amino Nitrogen mg./ 100 ml.
(1)		63.4	12.0	6.0
(2)	6.3	328.0	28.0	36.8
(3)		289.0	25.0	55.0
(4)	6.0	85.0 (0800 hr.)	22.0	74.4
		45.0 (2000 hr.)		31.9
(5)		40.0	19.0	20.0
(6)	7.1	40.0	15.0	14.0
(7)	6.3	45.0	15.0	8.0
(8)	6.1	50.0	16.0	6.0
(9)				
(10)	7.2	45.0	14.0	6.0
(11)		37.0		
(12)	7.5	50.0	18.0	6.0
(13)		44.0	15.0	
(14)				
(15)	7.7	27.3	15.0	6.0
(16)				
(17)	6.3	18.7	13.0	
(18)				
(19)	7.3	21.5	15.0	6.3

URINARY ELECTROLYTE CONTENT

(24 hour output given as grams and equivalents.)

Case No. 33-1945 (L.J.)

Day After Burn	24 Hr. Vol. ml.	Sodium		Potassium		Chloride		Phosphate	
		gm.	Eq.	gm.	Eq.	gm.	Eq	gm.	Eq.
(1)	1270	0.57	0.016	2.45	0.063	3.18	0.090	2.22	0.035
(2)	4700	4.00	0.174	2.70	0.069	9.22	0.260	3.21	0.055
(3)	5360	3.71	0.161	5.10	0.130	6.60	0.186	4.78	0.076
(4)	4360	2.62	0.114	5.57	0.143	2.79	0.078	3.82	0.060
(5)	5270	3.60	0.156	3.56	0.091	5.87	0.165	2.35	0.037
(6)	5380	4.04	0.176	1.89	0.048	8.08	0.228	1.62	0.026
(7)	1940	2.82	0.123	1.02	0.026	3.96	0.111	1.55	0.024
(8)	1940	2.82	0.123	1.02	0.026	3.96	0.111	1.55	0.024
(9)	3000	3.95	0.172	1.88	0.048	5.64	0.159	3.88	0.061
(10)	2710	1.49	0.065	1.56	0.040	3.50	0.099	2.94	0.046
(11)	4100	5.33	0.232	4.40	0.112	9.83	0.278	3.82	0.060
(12)	2100	1.52	0.066	2.78	0.071	1.64	0.046	4.13	0.065
(13)	4200	2.31	0.100	4.30	0.110	4.03	0.113	1.63	0.023
(14)	2300	4.14	0.180	3.28	0.084	5.67	0.160	3.00	0.047
(15)	3100	3.88	0.168	4.27	0.109	6.51	0.184	3.02	0.048
(16)	3250	4.88	0.212	4.07	0.104	8.00	0.226	5.83	0.092
(17)	1680	5.20	0.226	2.72	0.070	5.82	0.164	2.24	0.035
(18)	2930	6.60	0.287	4.72	0.121	7.98	0.224	4.50	0.071
(19)	2800	8.55	0.374	3.85	0.099	9.07	0.255	4.30	0.068
(20)	1710	6.58	0.286	2.22	0.057	7.53	0.212	2.19	0.034
(21)	1800	6.12	0.266	3.51	0.089	7.70	0.217	2.70	0.043
(22)	1850	4.73	0.206	2.73	0.070	5.53	0.155	2.54	0.040
(23)	2550	5.86	0.254	3.14	0.081	5.82	0.164	5.55	0.087
(24)	2400	7.80	0.339	3.57	0.091	7.42	0.209	4.13	0.065
(25)	2350	6.82	0.295	3.34	0.086	9.02	0.254	4.85	0.076
(26)	2100	5.35	0.232	2.81	0.072	7.53	0.212	3.12	0.049
(27)	2100	5.35	0.232	2.81	0.072	6.68	0.187	2.48	0.039
(28)	1400	3.36	0.146	1.72	0.044	4.14	0.116	1.50	0.024

URINARY NITROGEN CONTENT

Case No. 33-1945 (L.J.)

Day After Burn	24 Hour Volume in ml.	Non-Protein Nitrogen gm./24 hr.	Urea Nitrogen gm./24 hr.
(1)	1270	7.27	6.47
(2)	4700	10.80	8.03
(3)	1900	10.43	8.81
(4)	7820	17.37	14.02
(5)	5270	22.88	20.23
(6)	5380	17.70	17.05
(7)	1940	11.83	10.18
(8)	1940	11.83	10.18
(9)	3000	15.79	12.09
(10)	2710	9.33	7.10
(11)	4100	13.00	12.43
(12)	2100	13.83	12.68
(13)	4200	25.12	22.55
(14)	2300		12.77
(15)	3100	9.46	9.46
(16)	3250		15.63
(17)			
(18)	2930	21.10	17.70
(19)	2800	23.90	19.30
(20)	1710	11.27	8.23
(21)	1700	13.92	11.70
(22)	1850	12.62	10.60
(23)	2550	18.05	15.28
(24)	2400	14.07	12.88
(25)	2350		15.50
(26)	2100	12.30	11.00
(27)	2100	10.52	9.22
(28)	1400	8.87	7.34

HAEMATOLOGY

Case No. 33-1945 (L.J.)

Day After Burn	Hemat-ocrit %	Hemo-globin gm./ 100 ml.	Red Blood Cells million per cu.mm.	White Blood Cells thou-sand per cu.mm.	Neut-rophile %	Lymph-ocyte %	Mono-cyte %	Baso-phile %	Eosin-ophile %	Retic-ulocytes %
(1)	50	17.0	4.82	17.4	76	24				
(2)	35	15.0								
(3)	22	9.0								
(4)	20	8.0	3.23	30.2	78	22	1			6.2
(5)	23	8.5	2.75	25.3						
(6)	25	10.0	3.5	17.0						
(7)	28	9.5	3.68	21.1	76	22			2	3.5
(8)	24	7.4	3.3	14.8						4.0
(9)										
(10)		9.0	3.85	26.2	82	16	1			3.6
(11)	30	9.0	3.57	26.9	74	23		1	2	2.0
(12)		9.0	3.08	22.3	75	23			2	3.6
(13)		9.2	3.65	17.2	73	25			2	3.2
(14)	33	9.0	3.70	12.4	74	25			1	2.0
(15)		10.0	3.56	13.0	75	23			3	1.8
(16)		9.8	3.57	13.2	68	28			4	2.1
(17)		10.0	3.81	8.8	70	29			1	1.0
(18)	32	10.0	3.99	10.0	70	26	2		2	1.0
(19)		10.5	3.71	7.9	76	24				1.2
(20)										1.4

EXTRACELLULAR AND INTRACELLULAR DISTRIBUTION OF HEMOGLOBIN AND METHEMOGLOBIN IN WHOLE BLOOD.

Case No. 33-1945 (L.J.)

Day After Burn	Cells			Plasma		
	Hemoglobin gm./100 ml.	Methemoglobin %	Methemoglobin gm./100 ml.	Hemoglobin gm./100 ml.	Methemoglobin %	Methemoglobin gm./100 ml.
(1)	17.0					
(2)	15.0	1.9	0.28	0.27	0.0	0.00
(3)	9.0	3.0	0.27	0.40	10.0	0.04
(4)	8.0	10.4	0.83	0.73	23.9	0.11
(5)	8.5	8.0	0.68	0.21	10.0	0.02
(6)	10.0	0.0	0.00	0.12	0.0	0.00
(7)	9.5	0.0	0.0	0.05	0.00	0.00

HEMOGLOBIN CONTENT OF URINE

Day After Burn	Time	Volume	Hemoglobin gm.	Hemoglobin gm. of nitrogen
(1)	24 hr.	1270	0.00	0.00
(2)	24 hr.	4700	0.47	0.08
(3)	12 hr.	1900	2.21	0.34
	12 hr.	3460	5.84	0.86
(4)	24 hr.	4360	19.5	3.18
(5)	12 hr.	2470	3.16	0.52
	12 hr.	2800	0.00	0.00

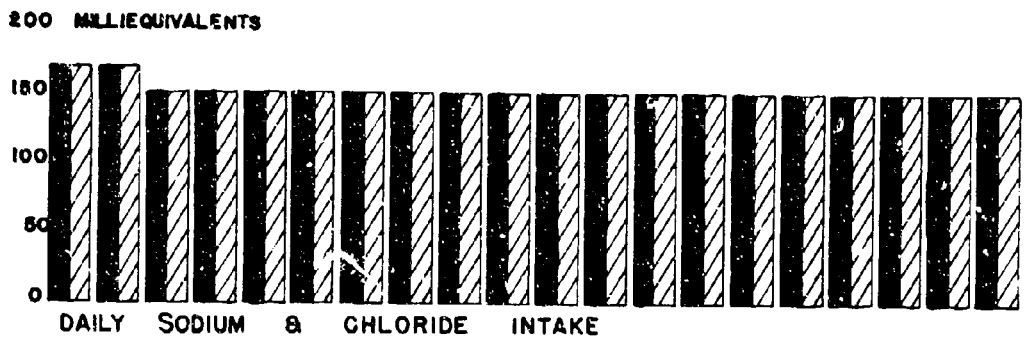
APPENDIX III

GRAPHIC REPRESENTATION OF DATA

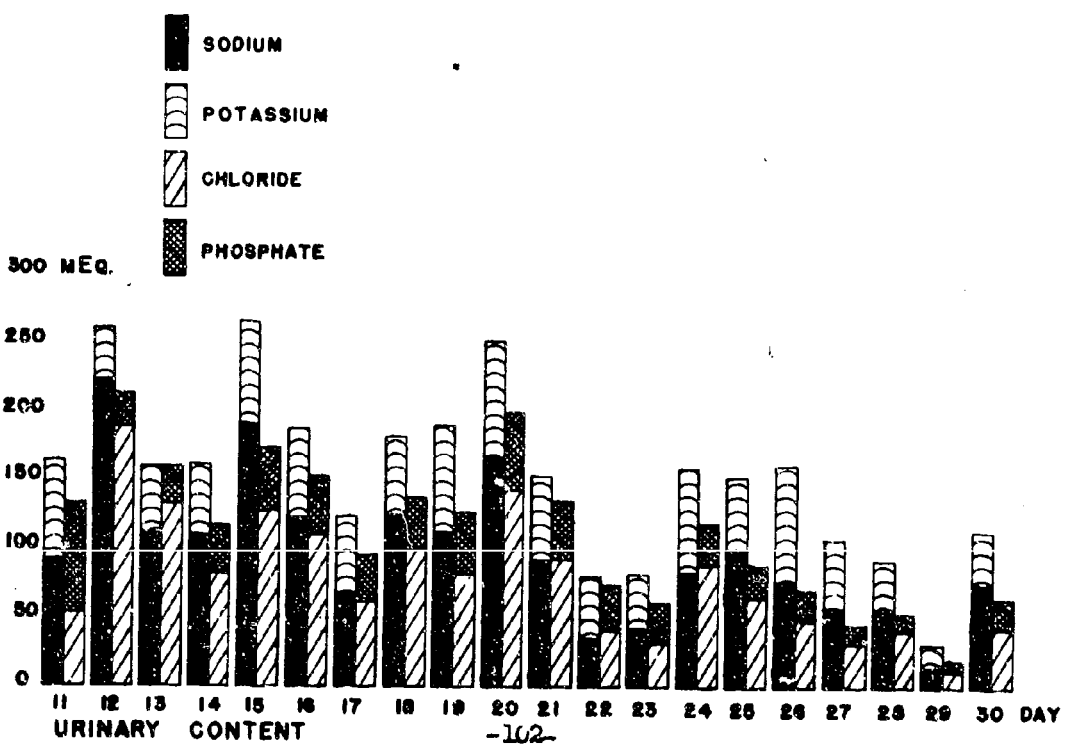
URINARY ELECTROLYTE CONTENT & SALT INTAKE

(EXPRESSED AS MILLIEQUIVALENTS PER 24 HOURS)

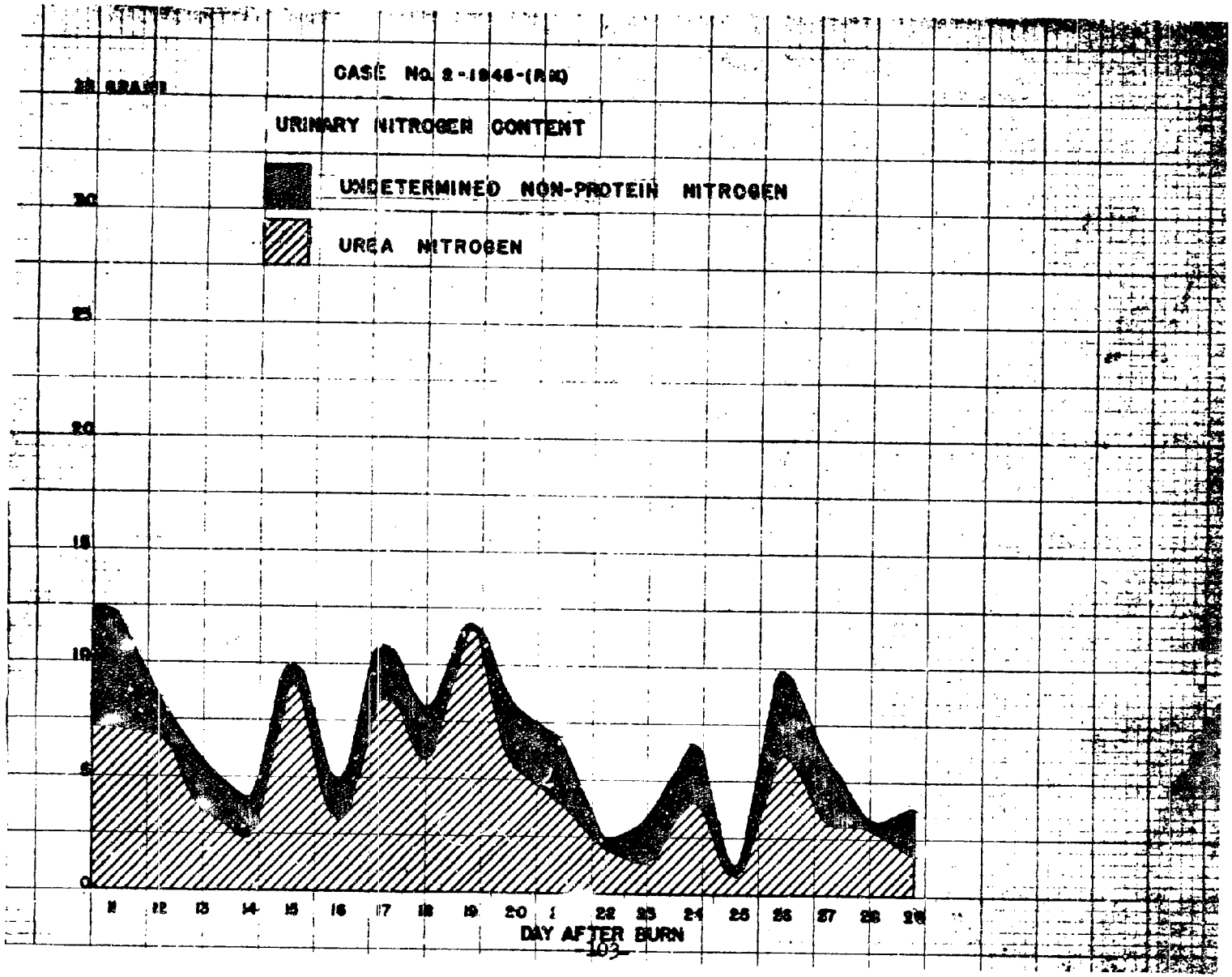
CASE NO. 2-1945-(P.N.)

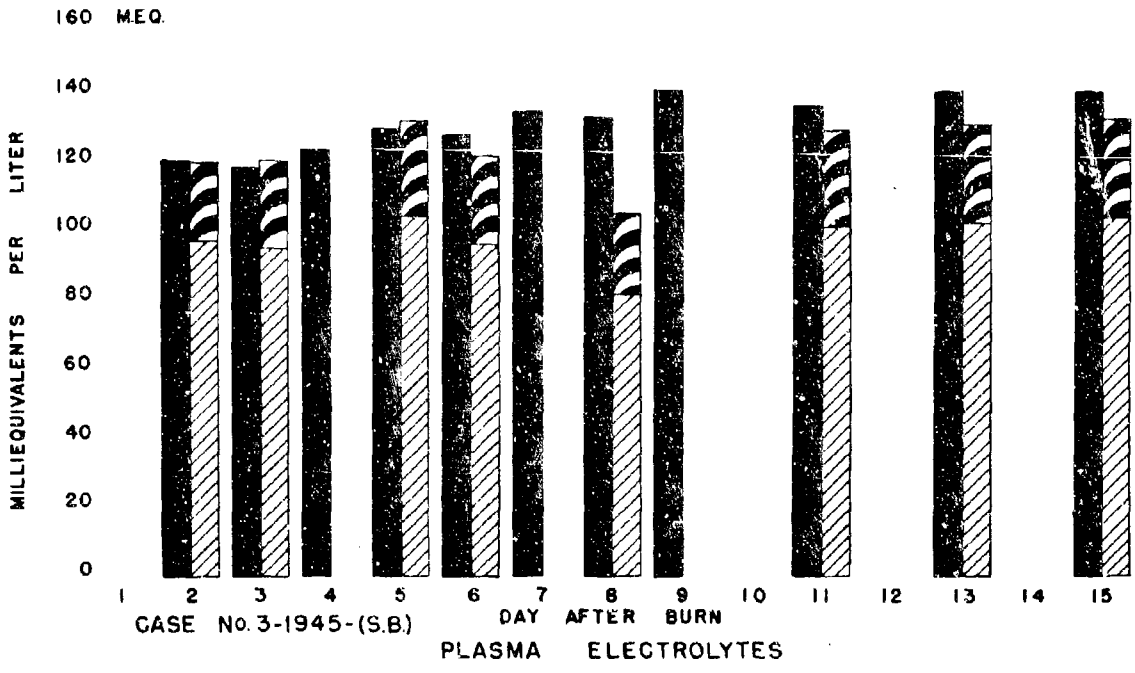


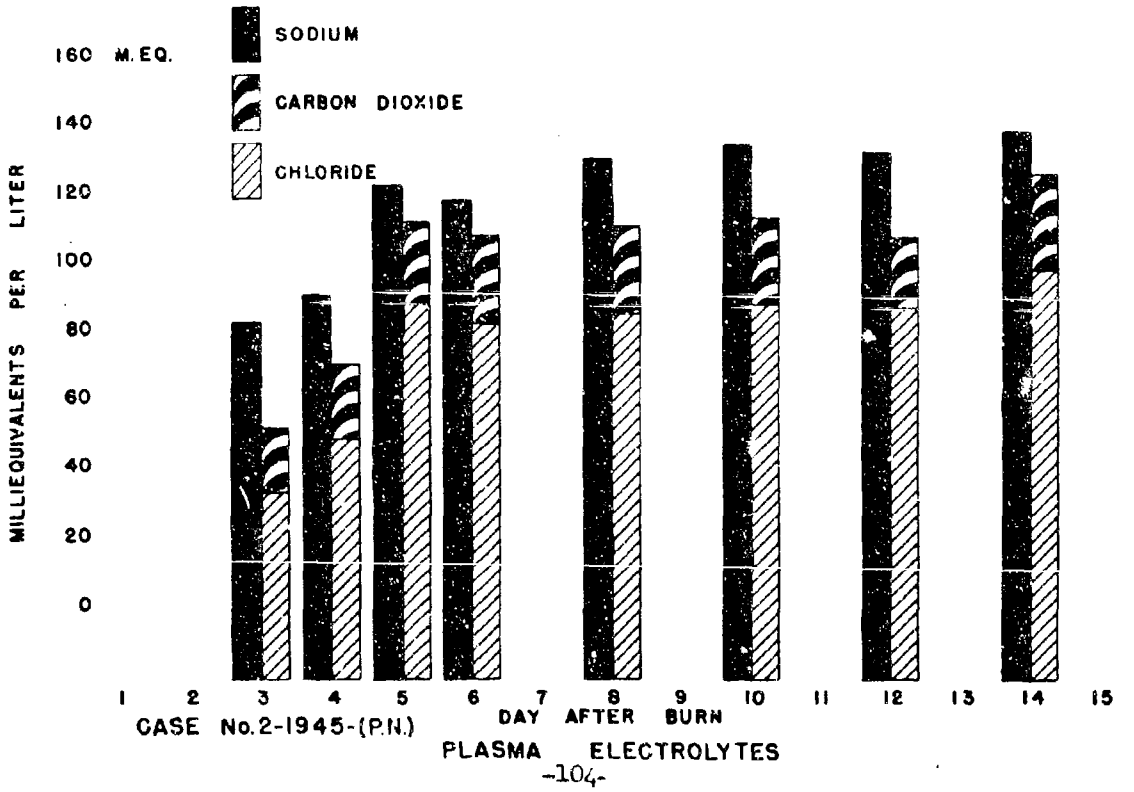
DAILY SODIUM & CHLORIDE INTAKE

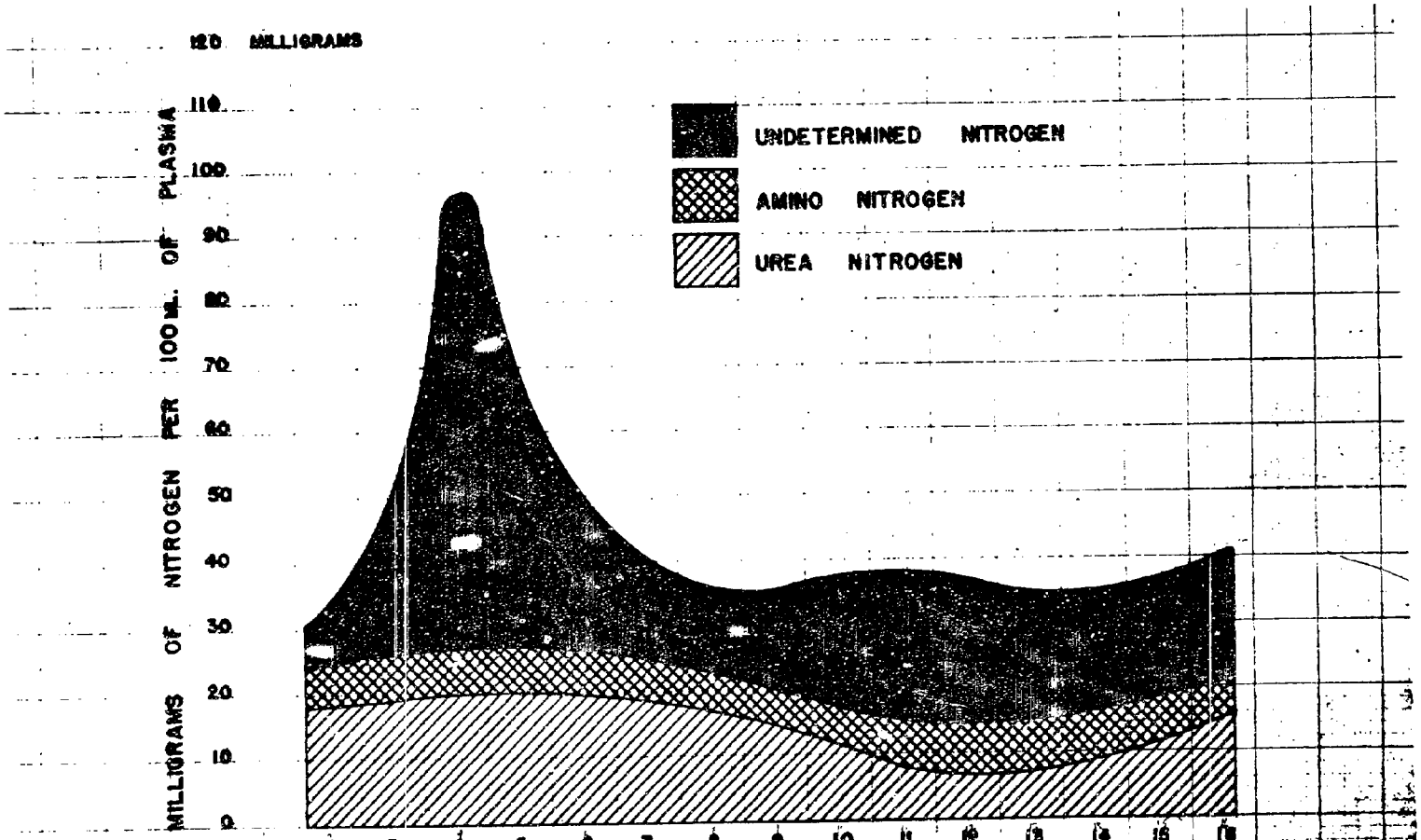


URINARY CONTENT


CASE NO. 2-1946-(R.M)
URINARY NITROGEN CONTENT
UNDETERMINED NON-PROTEIN NITROGEN
UREA NITROGEN
30
25
20
15
10
5
0
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
DAY AFTER BURN

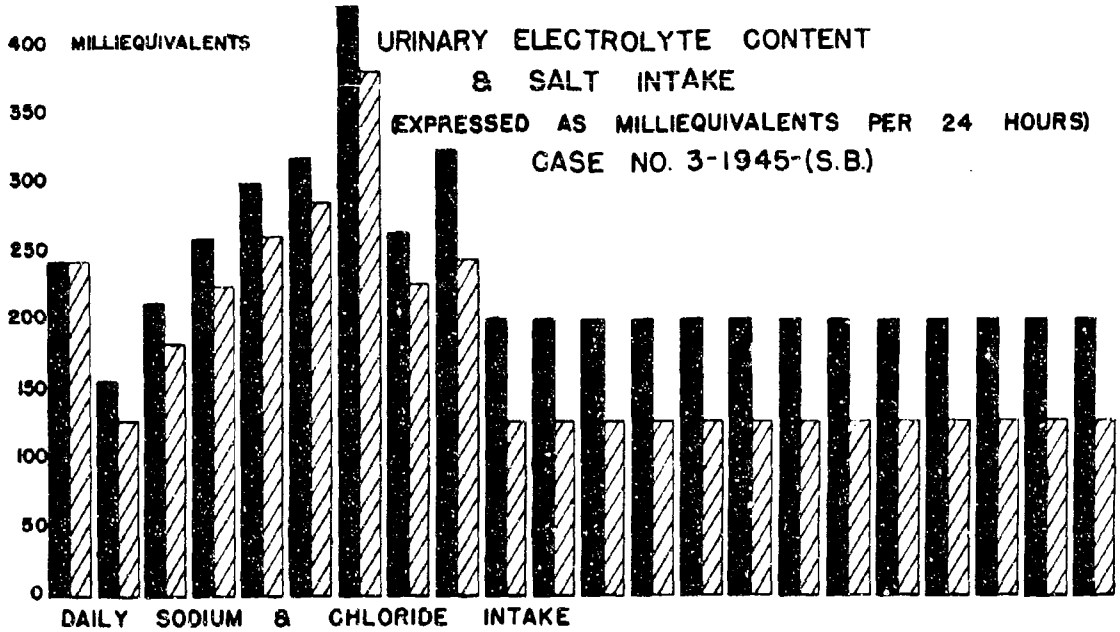

160 M.E.Q.
140
120
100
80
60
40
20
0
MILLIEQUIVALENTS PER LITER
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
DAY AFTER BURN
CASE No. 3-1945-(S.B.)
PLASMA ELECTROLYTES

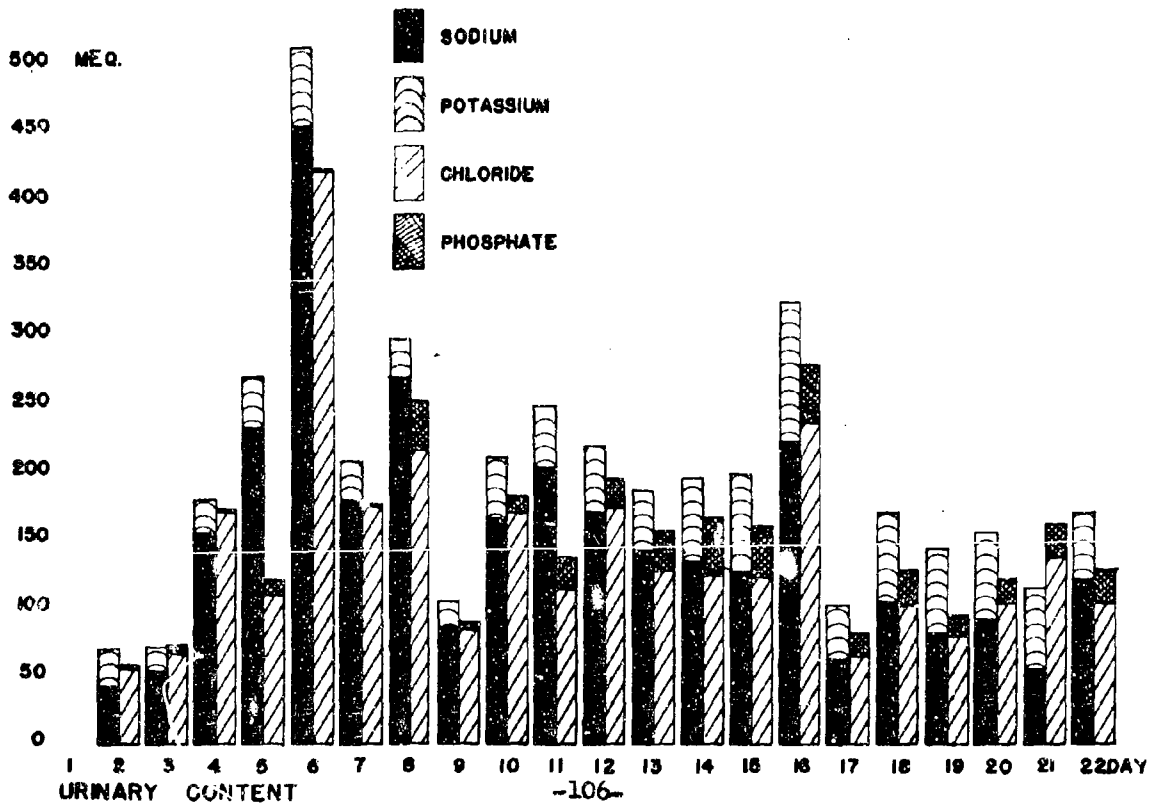

SODIUM
CARBON DIOXIDE
CHLORIDE
160 M.EQ.
140
120
100
80
60
40
20
0
MILLIEQUIVALENTS PER LITER
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
DAY AFTER BURN
CASE No. 2-1945-(P.N.)
PLASMA ELECTROLYTES



CASE No. 3-1945-(S.B.)

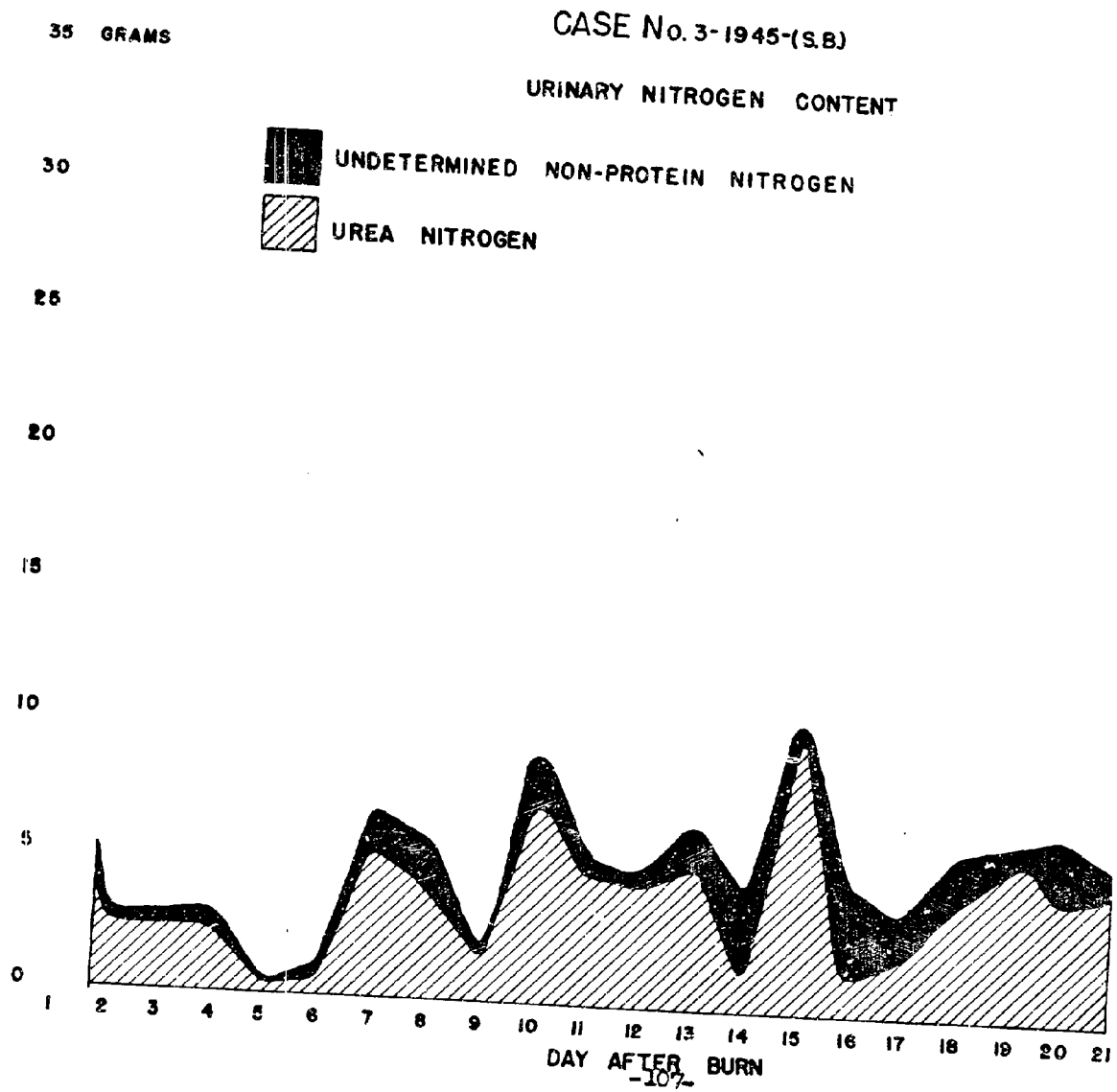
GRAPHIC REPRESENTATION OF INCREASE IN PLASMA NON-PROTEIN NITROGEN.


400 MILLIEQUIVALENTS
350
300
250
200
150
100
50
0
URINARY ELECTROLYTE CONTENT
& SALT INTAKE
(EXPRESSED AS MILLIEQUIVALENTS PER 24 HOURS)
CASE NO. 3-1945-(S.B.)
DAILY SODIUM & CHLORIDE INTAKE


500 MEQ.
450
400
350
300
250
200
150
100
50
0
SODIUM
POTASSIUM
CHLORIDE
PHOSPHATE
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22DAY
URINARY CONTENT

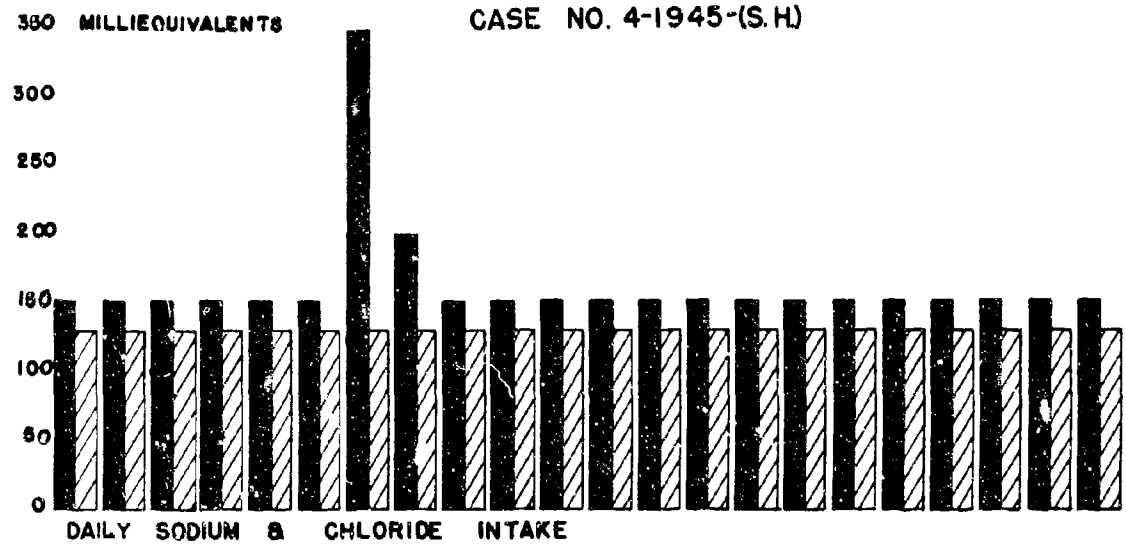
CASE No. 3-1945-(S.B.)

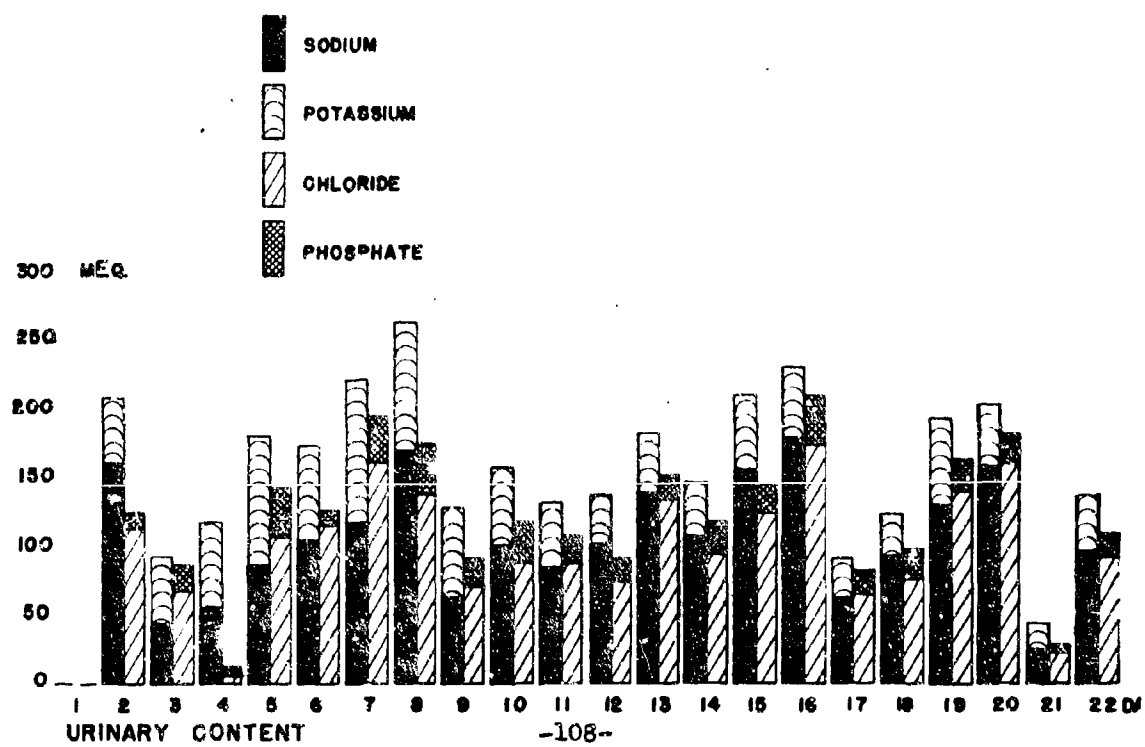
URINARY NITROGEN CONTENT



URINARY ELECTROLYTE CONTENT
& SALT INTAKE
(EXPRESSED AS MILLIEQUIVALENTS PER 24 HOURS)

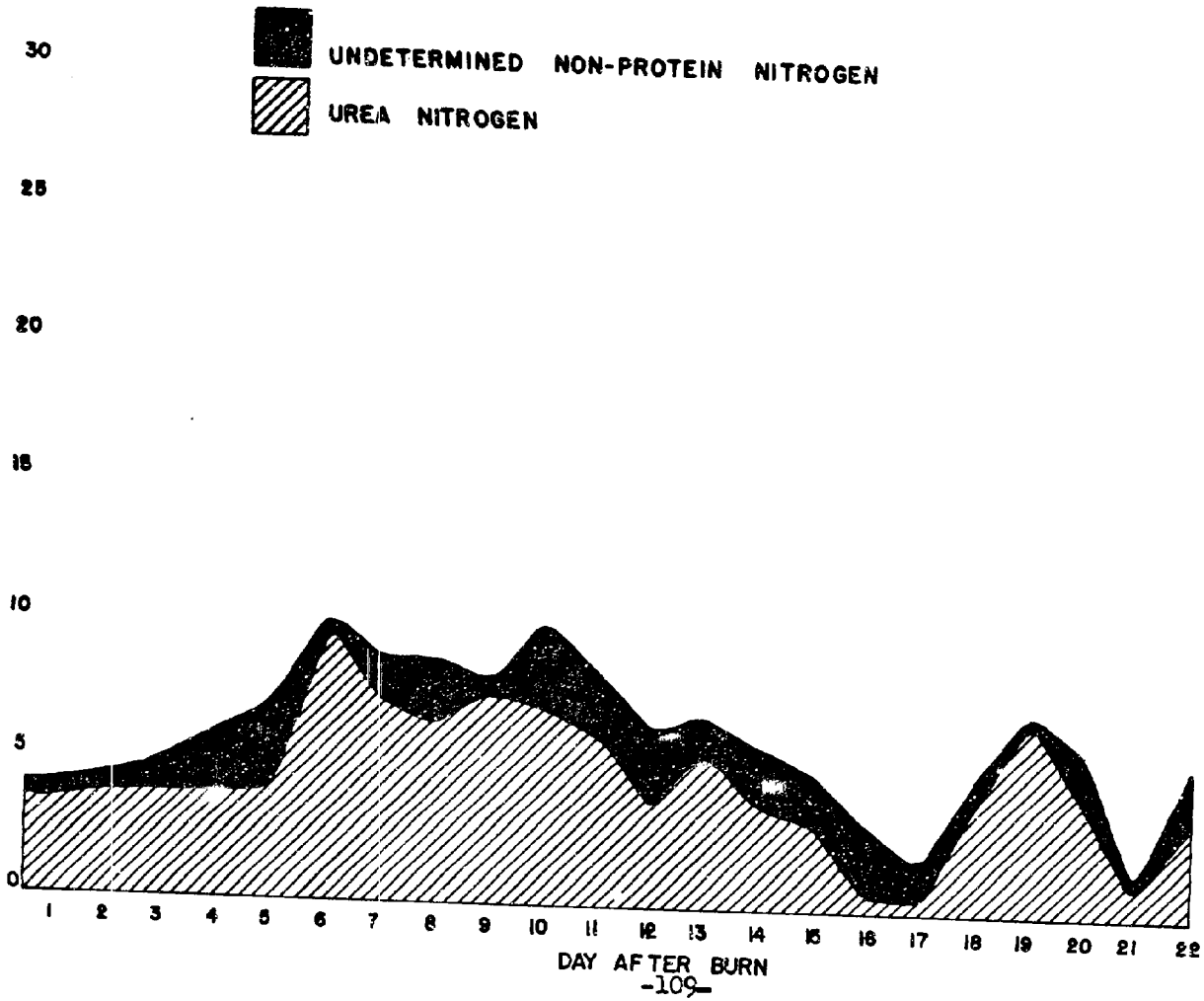
CASE NO. 4-1945-(S.H.)

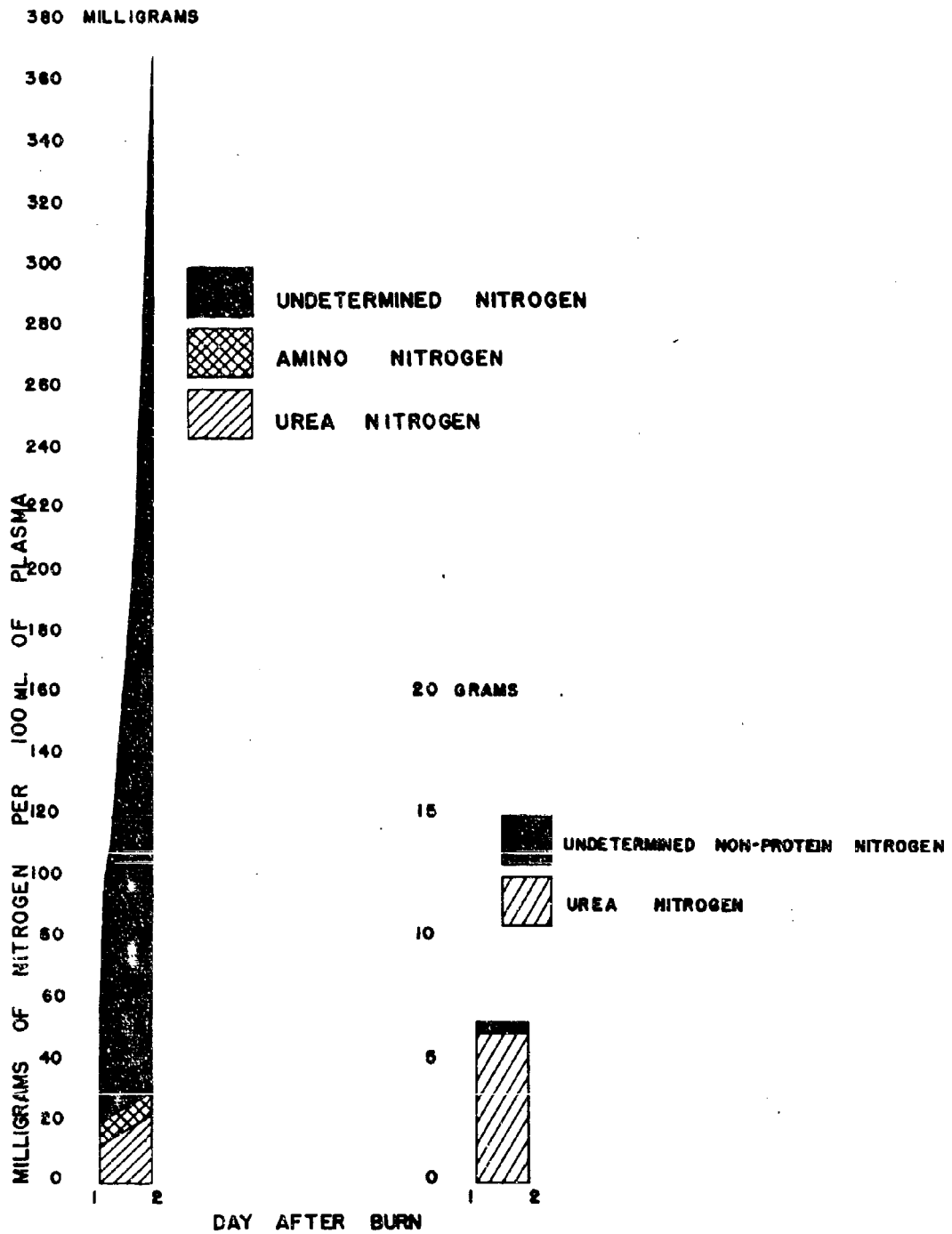




CASE No. 4-1945-(S.H)

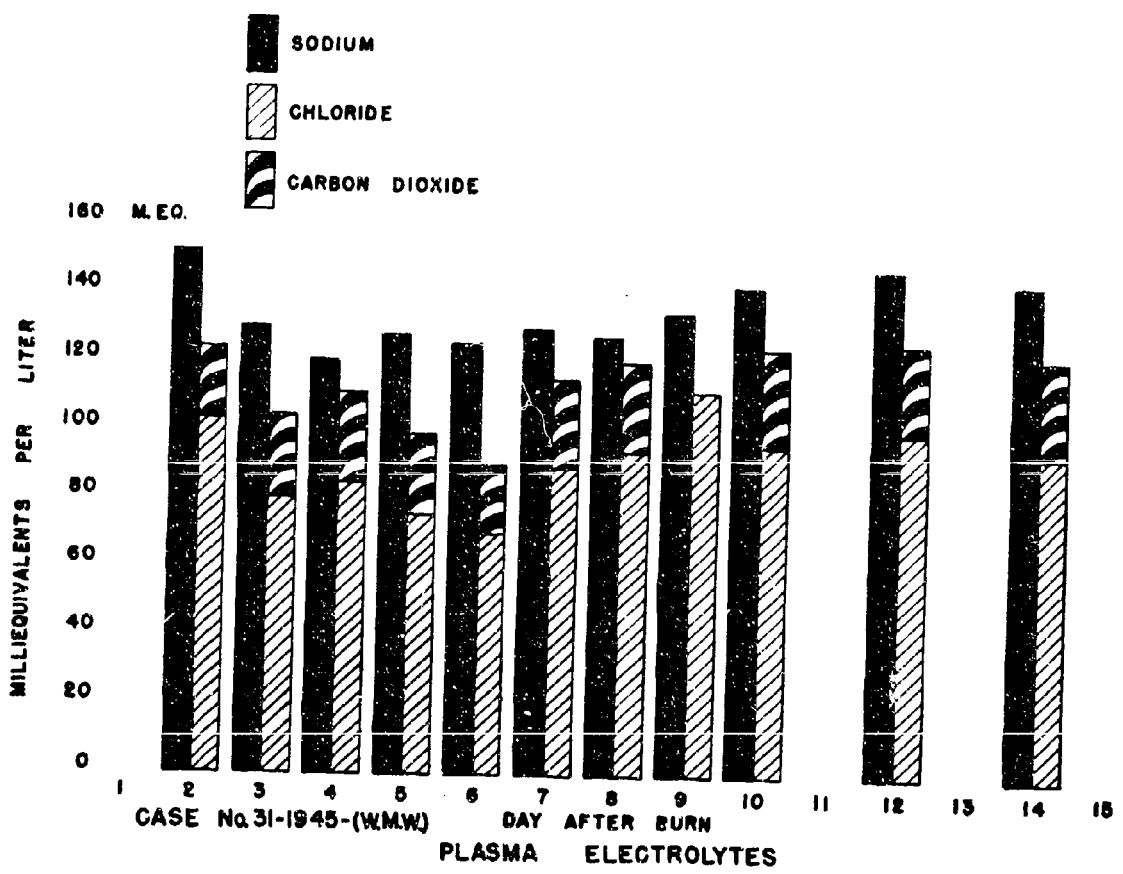
URINARY NITROGEN CONTENT

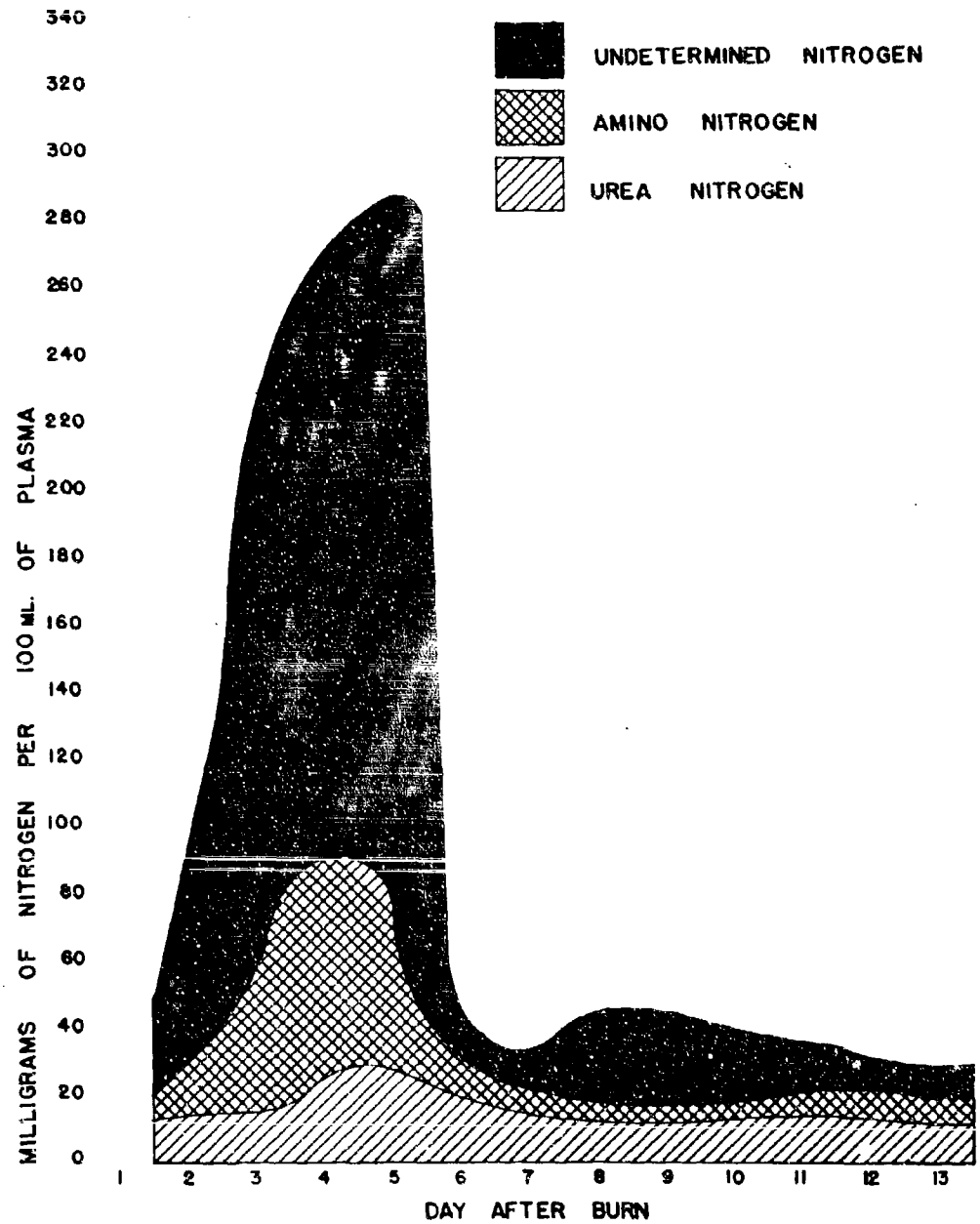




CASE No. 30-1945-(V.H)

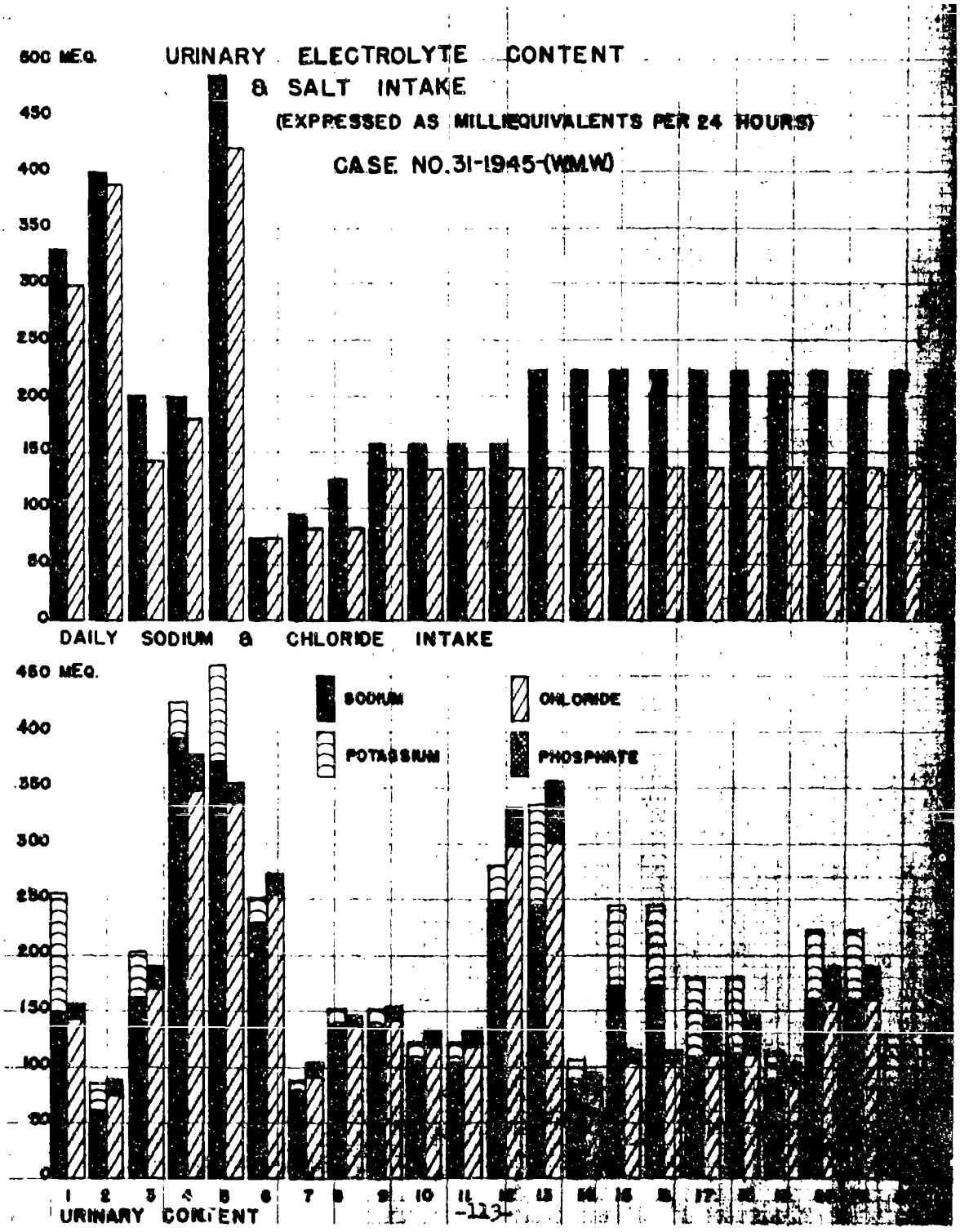
PLASMA NON-PROTEIN NITROGEN. URINARY NITROGEN.


SODIUM
CHLORIDE
CARBON DIOXIDE
160 M.EQ.
140
120
100
80
60
40
20
0
MILLIEQUIVALENTS PER LITER
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
CASE No. 31-1945-(W.M.W.)
DAY AFTER BURN
PLASMA ELECTROLYTES

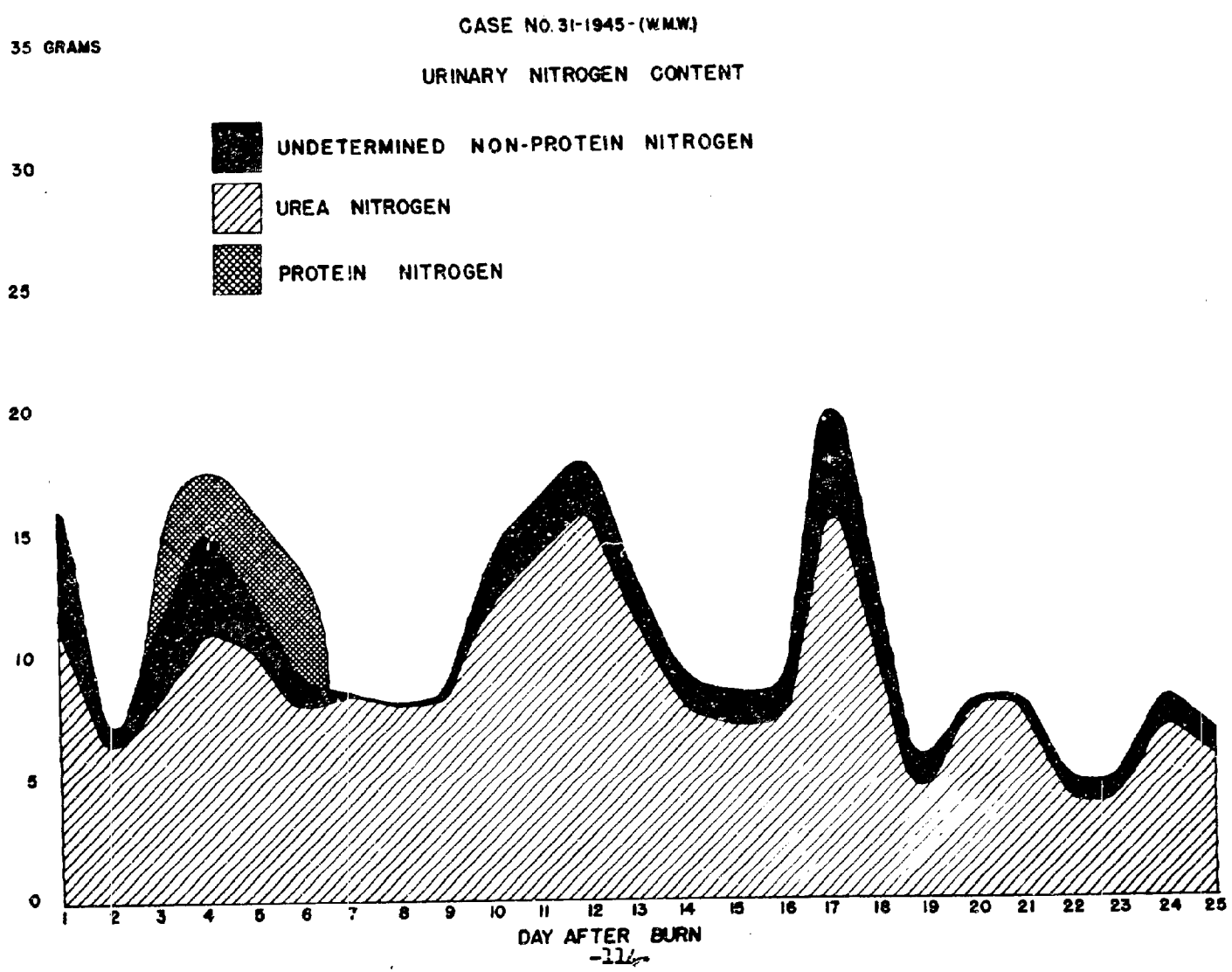


CASE No.31-1945-(W.M.W.)

GRAPHIC REPRESENTATION OF INCREASE IN PLASMA NON-PROTEIN NITROGEN AFTER BURN AND DURING HEMOLYSIS.

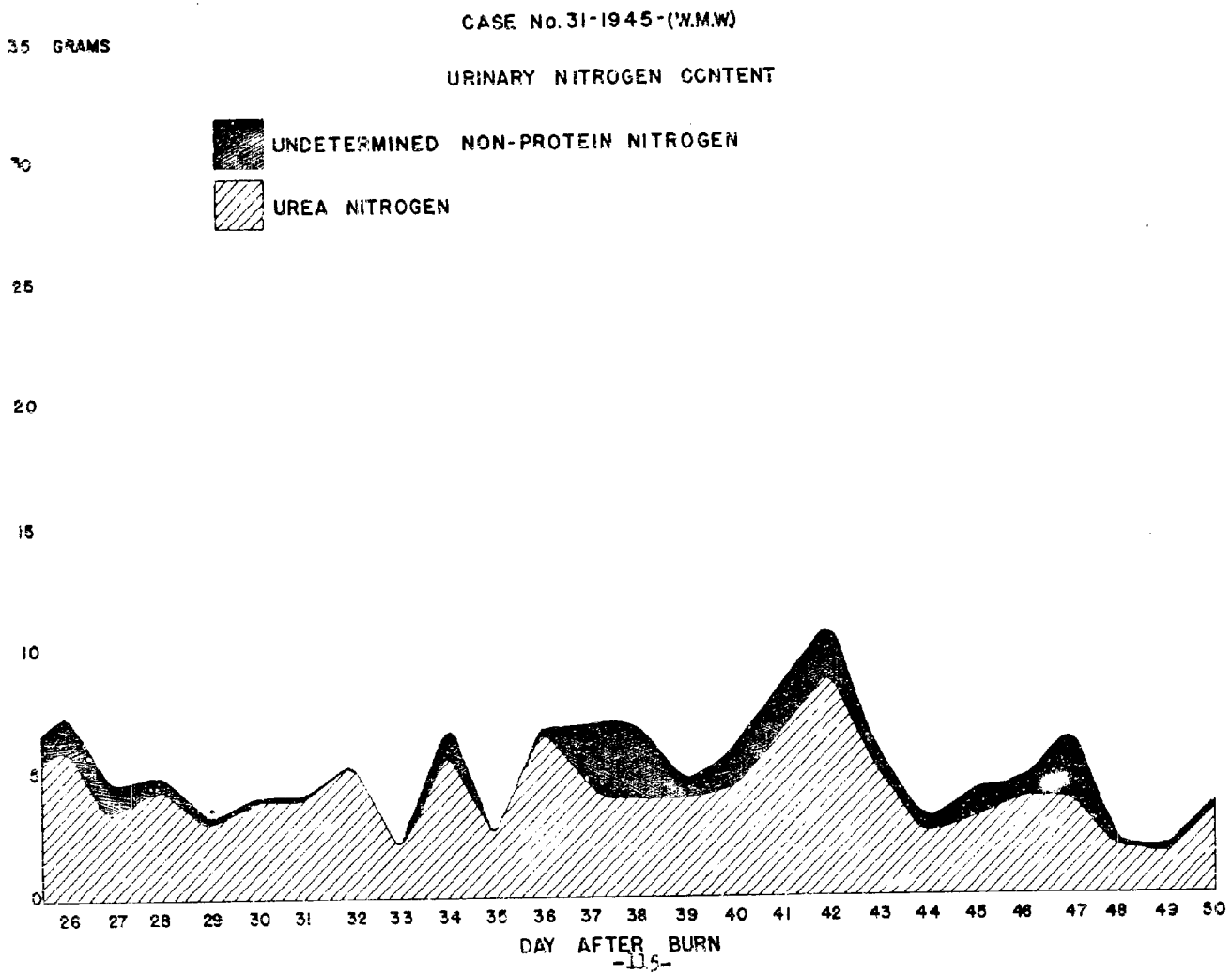

500 MEq.
URINARY ELECTROLYTE CONTENT
& SALT INTAKE
(EXPRESSED AS MILLIEQUIVALENTS PER 24 HOURS)
CASE NO. 31-1945-(WMW)
450
400
350
300
250
200
150
100
50
0
DAILY SODIUM & CHLORIDE INTAKE
450 MEq.
SODIUM
CHLORIDE
POTASSIUM
PHOSPHATE
400
350
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
URINARY CONTENT

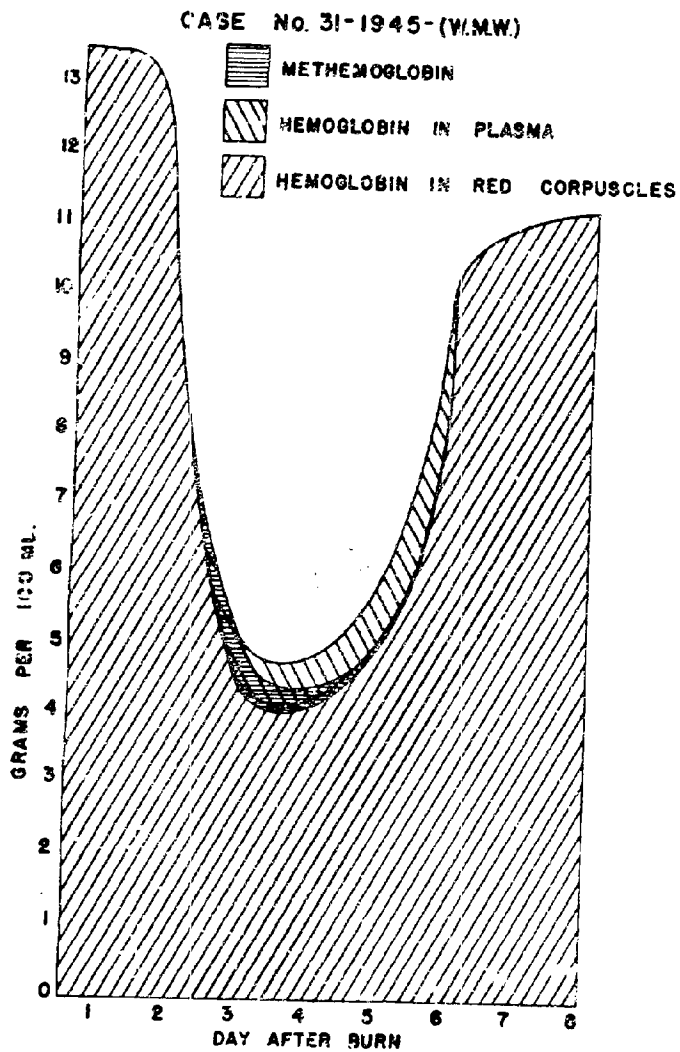
CASE NO. 31-1945-(W.M.W.)



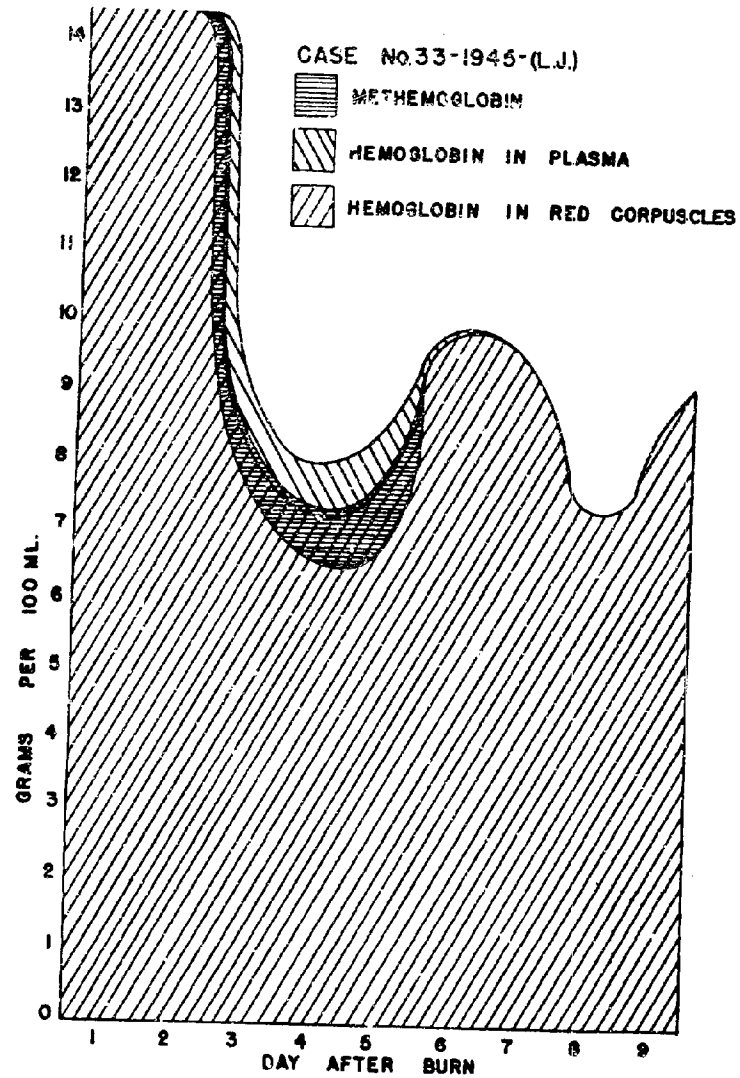
-11b-

CASE No. 31-1945-(W.M.W)

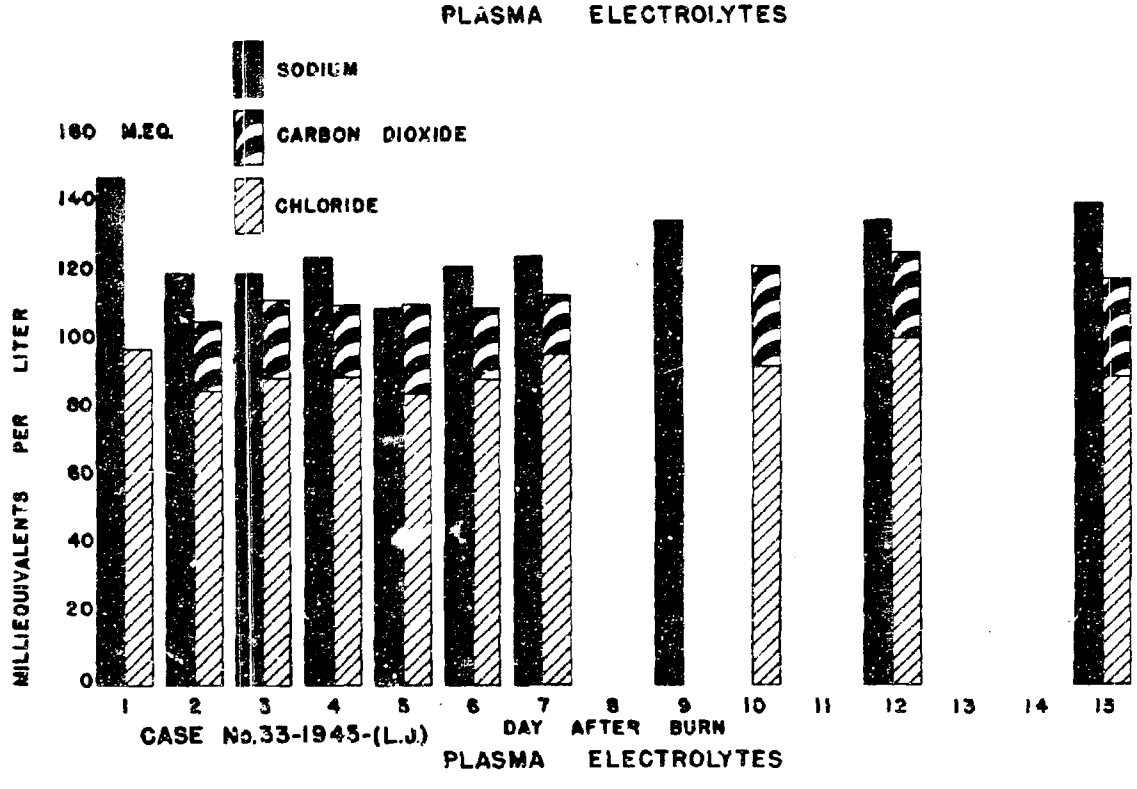


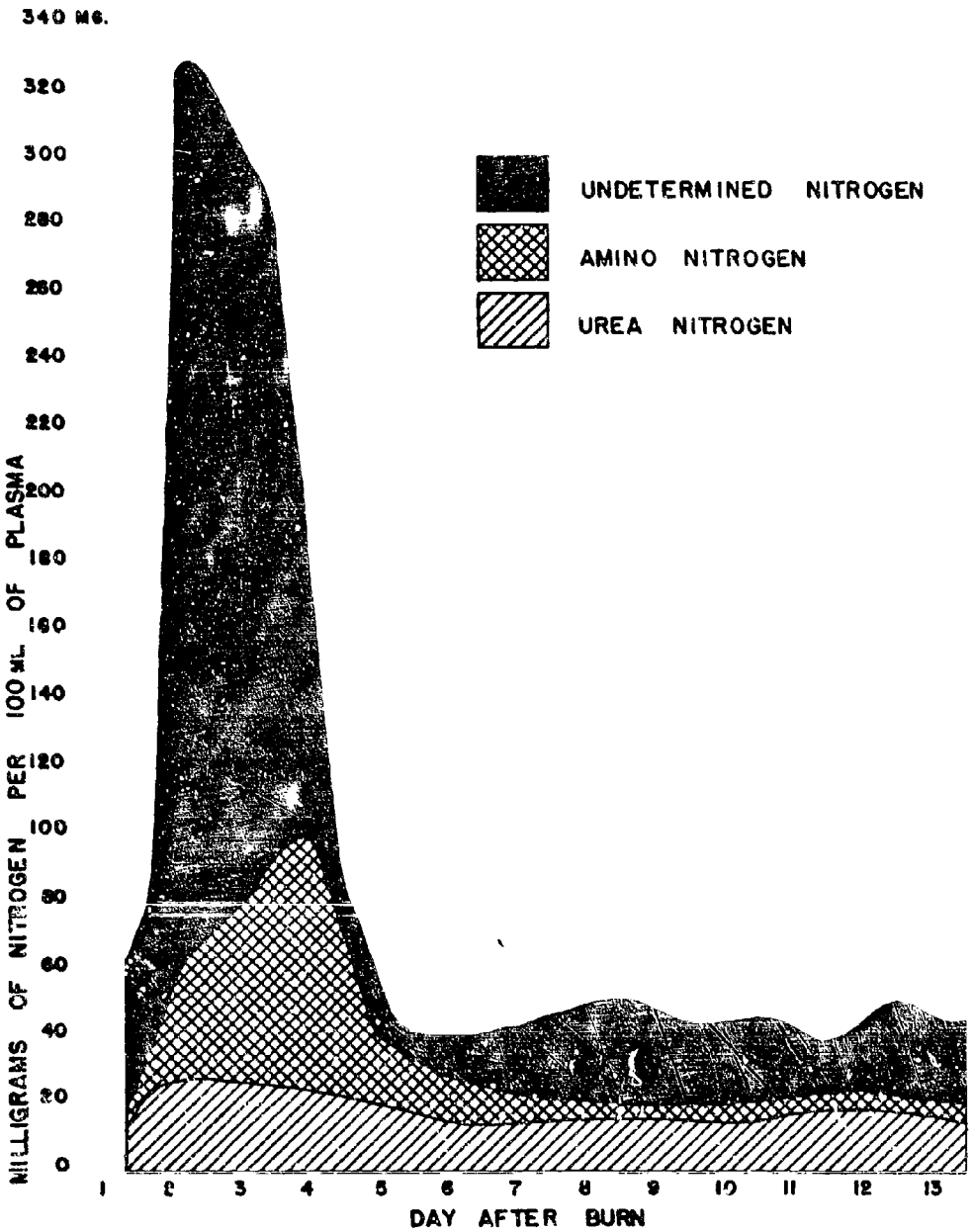


INTRACELLULAR AND EXTRACELLULAR DISTRIBUTION OF HEMOGLOBIN AND METHEMOGLOBIN IN BLOOD.



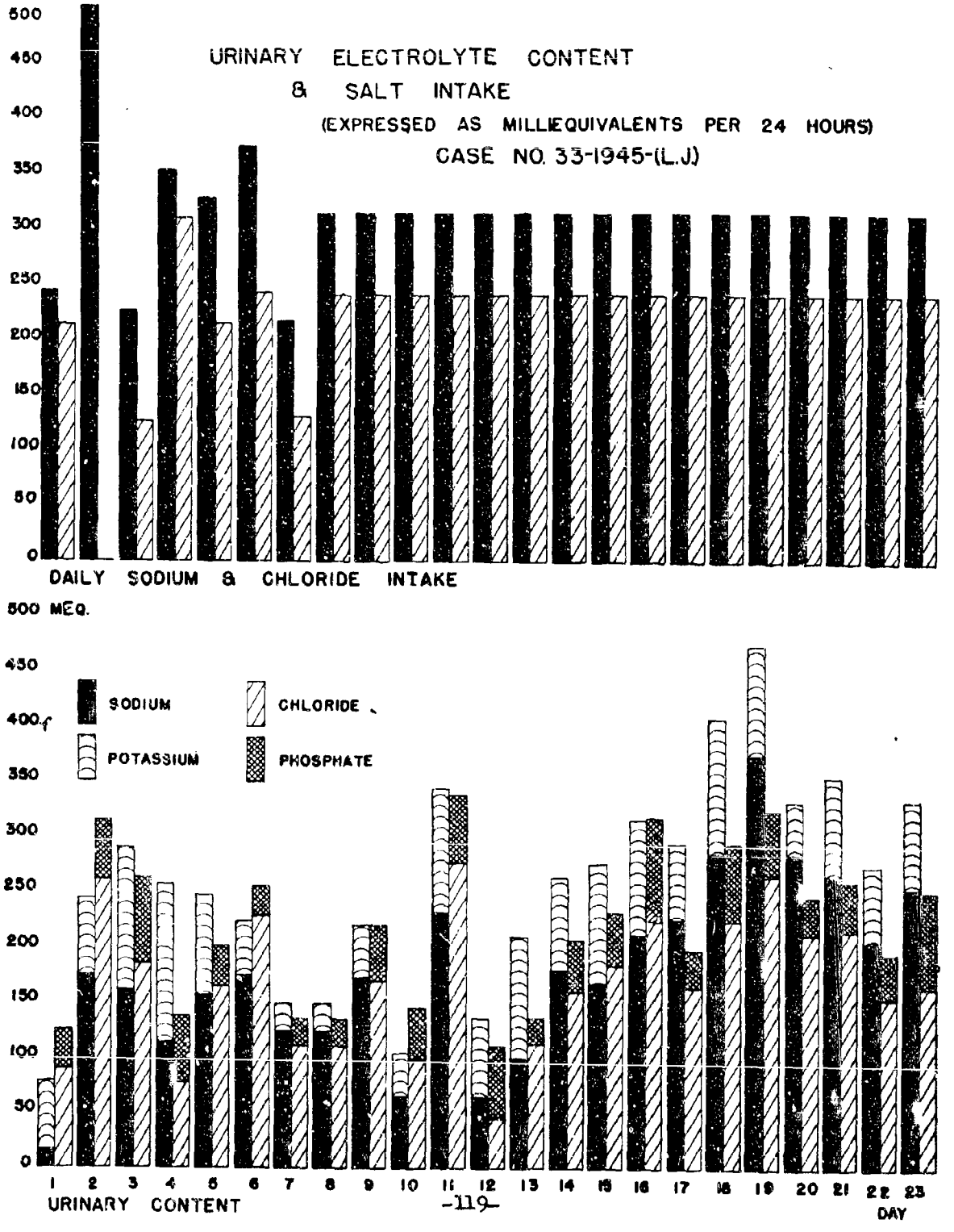
INTRACELLULAR AND EXTRACELLULAR DISTRIBUTION OF HEMOGLOBIN AND METHEMOGLOBIN IN BLOOD.


PLASMA ELECTROLYTES
SODIUM
CARBON DIOXIDE
CHLORIDE
160 M.EQ.
140
120
100
80
60
40
20
0
MILLIEQUIVALENTS PER LITER
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
DAY AFTER BURN
CASE No.33-1945-(L.J.)
PLASMA ELECTROLYTES



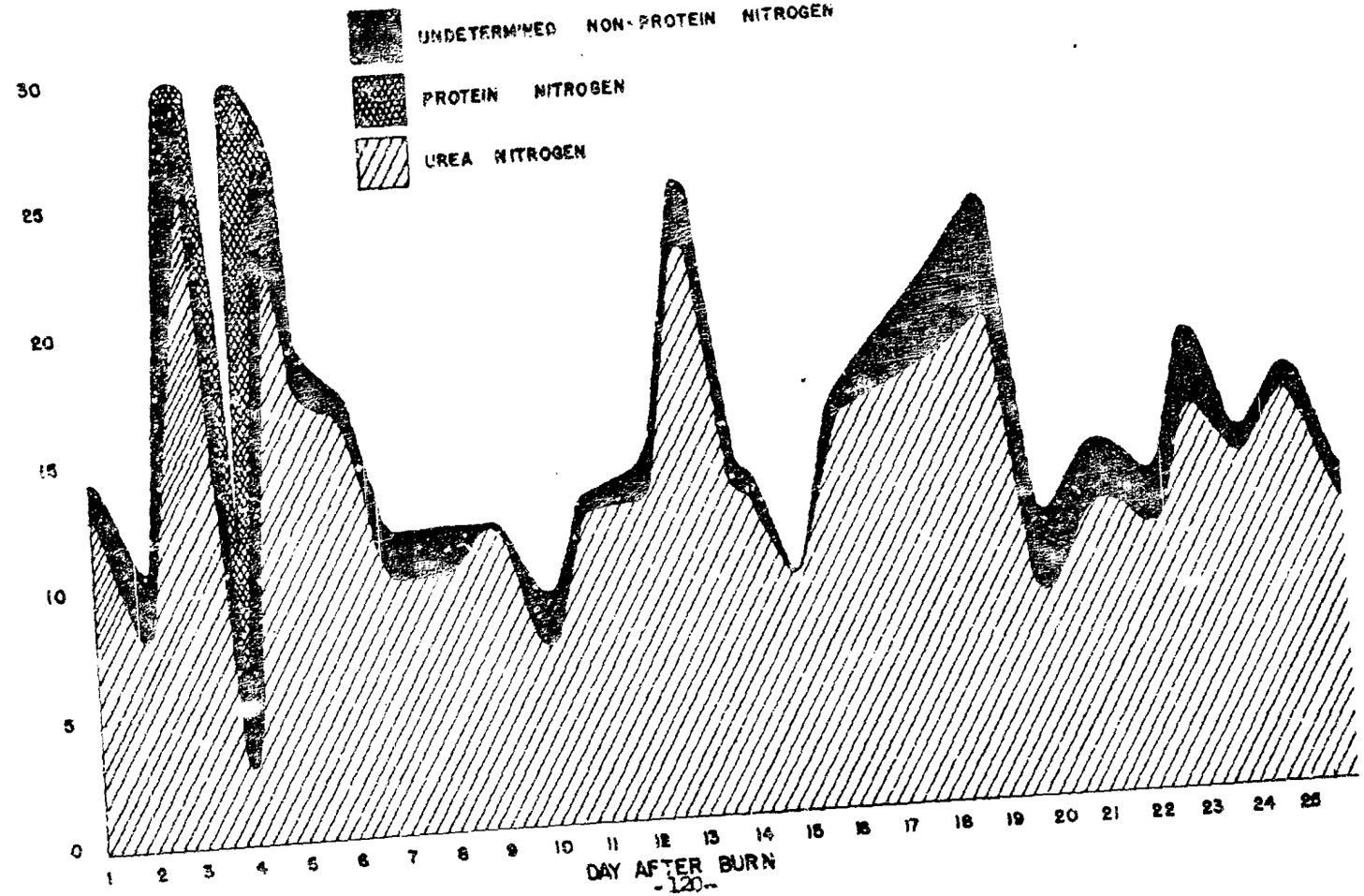
CASE NO. 33-1945-(L.J.)

GRAPHIC REPRESENTATION OF INCREASE IN PLASMA NON-PROTEIN NITROGEN AFTER BURN AND DURING HEMOLYSIS.


URINARY ELECTROLYTE CONTENT
& SALT INTAKE
(EXPRESSED AS MILLIEQUIVALENTS PER 24 HOURS)
CASE NO. 33-1945-(L.J.)
500
450
400
350
300
250
200
150
100
50
0
DAILY SODIUM & CHLORIDE INTAKE
500 MEQ.
450
400
350
300
250
200
150
100
50
0
SODIUM
CHLORIDE
POTASSIUM
PHOSPHATE
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
DAY
URINARY CONTENT

CASE NO.33-1945-(L.J.)

URINARY NITROGEN CONTENT



APPENDIX IV

Bacteriological Data

Three gram negative organisms were isolated from WP burns of three patients at the Station Hospital. These organisms were strains of E. Coli (Case No.4-1945 S.H.), Proteus vulgaris (Case No. 3-1945 S.B.) and Bacillus pyocyaneus (Case No. 2-1945 R.N.).

The amount of penicillin destroyed by these organisms and by the Heatly strain of Staph. aureus, which is the strain used for penicillin titrations, was determined. The technique employed was as follows: Penicillin was diluted with nutrient broth to a concentration of 40 units per ml. To 5 ml. of the 40 units/ml. penicillin in broth 5 ml. of an 18 hour culture of each of the test organisms Coli, Proteus, Pyocyaneus and Staph. were added, mixed and incubated at 37° C. for 2 hours. Two standards were done. To 5 ml. of the 40 units/ml. penicillin in broth 5 ml. of broth were added. A second tube was made up the same way. One was incubated for 2 hours at 37° C. and the other remained at ice box temperature for 2 hours. At the end of 2 hours all samples were filtered and the usual penicillin test tube titration was done on the filtrates. The results are as follows:

Organism	0.5 u. per ml.	0.2	0.1	0.08	0.06	0.05	0.04	0.03	0.02	0.015	0.01
Coli	0	0	0	0	0	0	0	-	-	-	-
Proteus	0	0	0	0	0	0	0	-	-	-	-
Pyocyaneus	0	0	0	0	0	0	0	0	-	-	-
Staph.	0	0	0	0	0	0	0	0	0	0	-
	.015	.01	.009	.008	.007	.006	.005	.004	.003	.002	.001
Standard incubated	0	-	-	-	-	-	-	-	-	-	-
Standard not incubated	0	-	-	-	-	-	-	-	-	-	-

There is no difference between the incubated and non-incubated standards. Both standards show that 0.015 units/ml. will prevent the growth of Staph. aureus. The tests indicate that 0.025 units of penicillin were destroyed in 2 hours by both Coli and Proteus while pyocyaneus destroyed 0.015 units. The Heatley strain of Staph. aureus did not destroy any penicillin in 2 hours.

APPENDIX V

Liver Function Data

Case No.	Bromsulf--alein. mg. %	Bilirubin mg. %	Cephalin Flocculation
No. 3-1945 (S.B.)	0.26		
No. 8-1945 (M.S.)	0.51	1.125	slight
No. 9-1945 (M.N.)	0.91		slight
No. 10-1945 (S.J.)	0.55	0.85	slight
No. 11-1945 (G.Z.)	0.47	0.93	slight
No. 30-1945 (V.H.)	0.54	0.95	one plus
No. 31-1945 (M.M.)	0.41	3.00	one plus
No. 33-1945 (L.J.)	0.56		

APPENDIX VI

CASE HISTORIES OF RESPIRATORY COMPLICATIONS

CASE 1, C. J., AGE 39, FEMALE, COLORED.

Immediate Symptoms: Cough, expectoration, shortness of breath, substernal tightness and pain, choking sensation, feeling of suffocation, hoarseness.

Past History: No history of pulmonary, cardiovascular or allergic disease.

Physical Findings on Admission to Edgewood Arsenal Station Hospital: The patient is in moderate respiratory distress. There is copious expectoration and a distressing cough. There is no cyanosis, orthopnea or edema. The neck veins are not distended. Chest expansion is symmetrical. Respirations are 30 per minute and are not shallow. Sibilant, sonorous and large moist rales and diminish[illegible]reath sounds are heard throughout the lungs. The pulse and ventricu[illegible]ates are 100 per minute; regular.

Course (Chart 1, Appendix VII): Cough and expectorations, soreness of the throat and dysphagia interfered with ingestion of foods during the first week. These gradually subsided toward the end of the second week. Shortness of breath subsided by the morning of the fourth day. The adventitious lung signs remained unchanged during the first week. Medium and large moist rales increased in number and breath sounds returned to normal during the second week. This was accompanied by a visible change in the character of the sputum. Previously it appeared green-yellow and consisted mainly of mucoid and semi-solid matter which settled to the bottom. Now it became watery and contained relatively small amounts of mucoid matter. Many bronchial casts were present in the sputum of the first day. At no time was the odor definitely foul. Hoarseness and injection and swelling of the larynx and vocal cords were still present but to a lesser degree at the time of discharge from the hospital on the twenty-third day. Treatment for hoarseness consisted of steam with tincture of benzoin inhalations four times a day from the seventh to the eighteenth day and spray of the nose and pharynx twice daily with neosynephrin 1/2% from the eighteenth day to the time of discharge from the hospital.

Roentgenograms of the Lungs (Figure 2, Appendix VII) 18 Hours after Exposure: Accentuation of bronchovascular markings, haziness and mottling in both lower lung fields, in the mid-portion of the left lung at the level of the hilum and increased hilar shadows bilaterally. Fifth day: there was considerable improvement; haziness in both lower lung fields was considerably diminished and shadow in mid-portion left lung was gone. Eighth day: for the most part haziness was gone, bronchovascular markings in both lower lung fields were accentuated. Ninth day: normal except for increased bronchovascular markings. This was still present at time of discharge.

Sputum Examinations: (1) Culture (aerobic and anerobic in enriched-blood agar medium and also Sabouraud's medium). Second day: pneumococcus type 17, diphtheroid bacilli, neisseria catarrhalis. Fifth day: diptheroid bacilli, neisseria catarrhalis. Sixth day: great predominance of streptococci, which were sensitive to penicillin, and two yeast colonies. (2) Smears: (gram and carbol crystal stains). Third day and fifth day: gram positive cocci, bacilli and filamentous forms; epithelial cells, no spirillae. (3) Dark Field: Third day: spirillae not present.

Blood Culture: Fourth day: no growth after 10 days.

Urine: The results of several urine examinations were normal except for 2+ albuminuria which appeared on the second day of sulfadiazine and sodium bicarbonate administration and continued for three days after they were discontinued. There was no azotemia.

Course Following Discharge from Hospital: The patient has been symptom free except for persistent hoarseness and expectoration of about 1/2 to 1 ounce of non-foul yellow-white sputum a day. The vocal cords and larynx appeared normal at about six weeks after discharge from the hospital. When last seen, approximately two and one-half months following discharge from the hospital, there had been only slight improvement in her voice. She appeared well and was afebrile. The lungs were clear. The vocal cords and larynx appeared normal by indirect laryngoscopy. A roentgenogram of the lungs taken on July 25, more than two months following discharge from the hospital, still exhibited increased bronchovascular markings. A bronchogram taken on August 13, approximately two and one-half months after discharge, did not exhibit any definite evidence of bronchiectasis.

CASE 2, S. E., AGE 45, FEMALE, COLORED.

Immediate Symptoms: Cough, expectoration, shortness of breath, choking sensation, feeling of suffocation, constant substernal tightness and pain, hoarseness.

Past History: No history of pulmonary, cardiovascular or allergic disease.

Physical Findings on Admission to Edgewood Arsenal Station Hospital: The patient is in moderate respiratory distress, coughs frequently and has copious expectoration. There is no cyanosis, orthopnea or edema. The neck veins are not distended. Chest expansion is symmetrical. Respirations are 26 per minute. They are not shallow. There are numerous sibilant and sonorous rales throughout the lungs. The level of arterial pressure is 110/70. The ventricular and pulse rates are 100 per minute.

Course (Chart 2, Appendix VII): All the immediate symptoms except expectoration and hoarseness gradually subsided during the first two days. Oxygen was administered continuously by nasal mask (6 to 8 liters per minute) during the first 2-1/4 days primarily because it gave much relief from coughing. Adventitious lung signs disappeared by the third day. Cough gradually subsided by the fourth day. The expectoration was mucoid, tenacious, non-foul. It contained bronchial casts on the third day. Edema of the vocal cords had disappeared and injection had almost entirely subsided by the sixth day. The vocal cords and larynx appeared normal by the thirteenth day at which time the voice returned to normal. Treatment for hoarseness consisted of steam with tincture of benzoin inhalations for fifteen minutes every three hours during the day from the fifth day to the thirteenth day. The level of arterial pressure on several estimations was 110/70. The patient was discharged on the sixteenth day of hospitalization.

Roentgenograms of the Lungs (Figure 3, Appendix VII): Approximately eighteen hours after the accident, there was increased prominence of the bronchovascular markings and hilar shadows, the remainder of the lung fields appeared normal. Fifth day: lungs appeared normal.

Bronchogram: Performed on twelfth day, appeared normal.

Sputum Examination: (1) Culture (aerobic and anaerobic in enriched blood agar medium). Second day: pneumococcus type 23, diptheroid bacilli, neisseria catarrhalis, non-hemolytic alpha streptococci and non-hemolytic micrococcus tetragenous. Fourth day: Diptheroid bacilli and neisseria catarrhalis.

Smears: (gram and carbol crystal stains): Third and fifth days: few gram positive cocci, bacilli and filamentous forms, no spirillae, few epithelial cells.

Dark Field: Third day: no spirillae.

Urine: No abnormalities.

Course Following Discharge: When seen on August 1, approximately two and one-half months following discharge from the hospital, the patient complained

of intermittent periods of hoarseness of several days duration, frequent colds and sore throat which come on after exposure to draughts. She has been expectorating about 5 to 10 cc. of non-foul, tenacious sputum a day. She was hoarse. The pharynx and mucous membrane of the mouth appeared normal. The lungs were clear. She was afebrile. The ventricular and pulse rates were 80 per minute and the level of arterial pressure was 130/90. A roentgenogram of the lungs was normal and the larynx and vocal cords appeared normal.

CASE 3, E. S., AGE 23, FEMALE, COLORED.

Immediate Symptoms: Cough, expectoration, substernal tightness.

Past History: No history of allergic or cardiovascular disease. One month prior to the accident the patient had a severe "head and chest cold", which lasted about one week.

Physical Findings on Admission to Edgewood Arsenal Station Hospital. Coughs frequently and expectorates mucoid sputum. There is no cyanosis, orthopnea or edema. The neck veins are not distended. Chest expansion is symmetrical. Respirations are 20 per minute and not shallow. There are sibilant and sonorous rales throughout the lungs. The pulse and ventricular rates are eighty per minute. The level of arterial pressure is 112/60.

Course (Chart 3, Appendix VII): The adventitious lung signs and substernal tightness cleared by the third day. Cough and copious expectoration were at times distressing, particularly late at night. They had both gradually subsided by the time the patient was discharged from the hospital on the sixteenth day. The sputum was watery in consistency and contained relatively little mucoid and semi-solid matter. It did not contain any bronchial casts. The larynx appeared normal by indirect laryngoscopy on the second day.

Roentgenogram of the lungs: Approximately eighteen hours after the accident and on the fifth day - appeared normal.

Sputum Examinations: (1) Culture (aerobic and anerobic in enriched blood agar medium and also in Sabouraud's medium). Second day: few pneumococci, neisseria catarrhalis. Sixth day: staphlococci, few streptococci and diphtheroids. (2) Smears (gram and carbol crystal stains): Third and fifth days: few gram positive cocci, bacilli, and filamentous forms, no spirillae; few epithelial cells. (3) Dark field: Third day - spirillae not seen.

Urine: The results of several urine examinations were normal.

Course following discharge from Hospital: The patient has continued to be in good health and symptom free. When last seen on August 1, almost two months following discharge from the hospital, she did not exhibit any abnormal physical findings. A bronchogram performed that day appeared normal.

CASE 4, R. M., AGE 23, FEMALE, COLORED.

Immediate Symptoms: Cough, substernal pain and tightness in chest. Pain in knees, hands, arms due to white phosphorous burns.

Past History: No history of pulmonary, cardiovascular or allergic disease. Had a "chest cold" about one week prior to the accident and expectorated about one ounce of tenacious, non-foul, yellow sputum a day for a few days.

Physical Findings on Admission to Edgewood Arsenal Station Hospital: The patient coughs infrequently and occasionally expectorates small amounts of tenacious, mucoid, non-foul, yellow sputum. There is no respiratory distress or cyanosis. Chest expansion is symmetrical and not limited. Respirations are 20 per minute and are not shallow. There are numerous sibilant and sonorous rales throughout the lungs. The pulse and ventricular rates are 90 per minute. The level of arterial pressure is 120/70. There are spotty second and third degree white phosphorous burns of the hands, forearms and knees. The total area burned is about six square inches.

Course (Chart 4, Appendix VII): Tightness in the chest, substernal pain, and adventitious lung signs subsided during the first twelve hours. Cough stopped by the third day and expectoration on the sixth day. The sputum was glairy, grey, non-foul. The patient remained in the hospital for treatment of burns of the extremities for weeks and did not exhibit symptoms or signs referable to the respiratory system.

Roentgenogram of the Lungs: Eighteen hours after exposure - normal.

Sputum Examination: (1) Culture (aerobic and anerobic in enriched blood agar medium). Second day: diptheroid bacilli, neisseria catarrhalis, occasional pneumococci. Fifth day: neisseria catarrhalis. (2) Smears (gram and carbol crystal stains): Third day: gram positive cocci, bacilli and filamentous forms; epithelial cells; no spirillae.

Urine: No abnormal findings.

APPENDIX VII

RESPIRATORY COMPLICATIONS

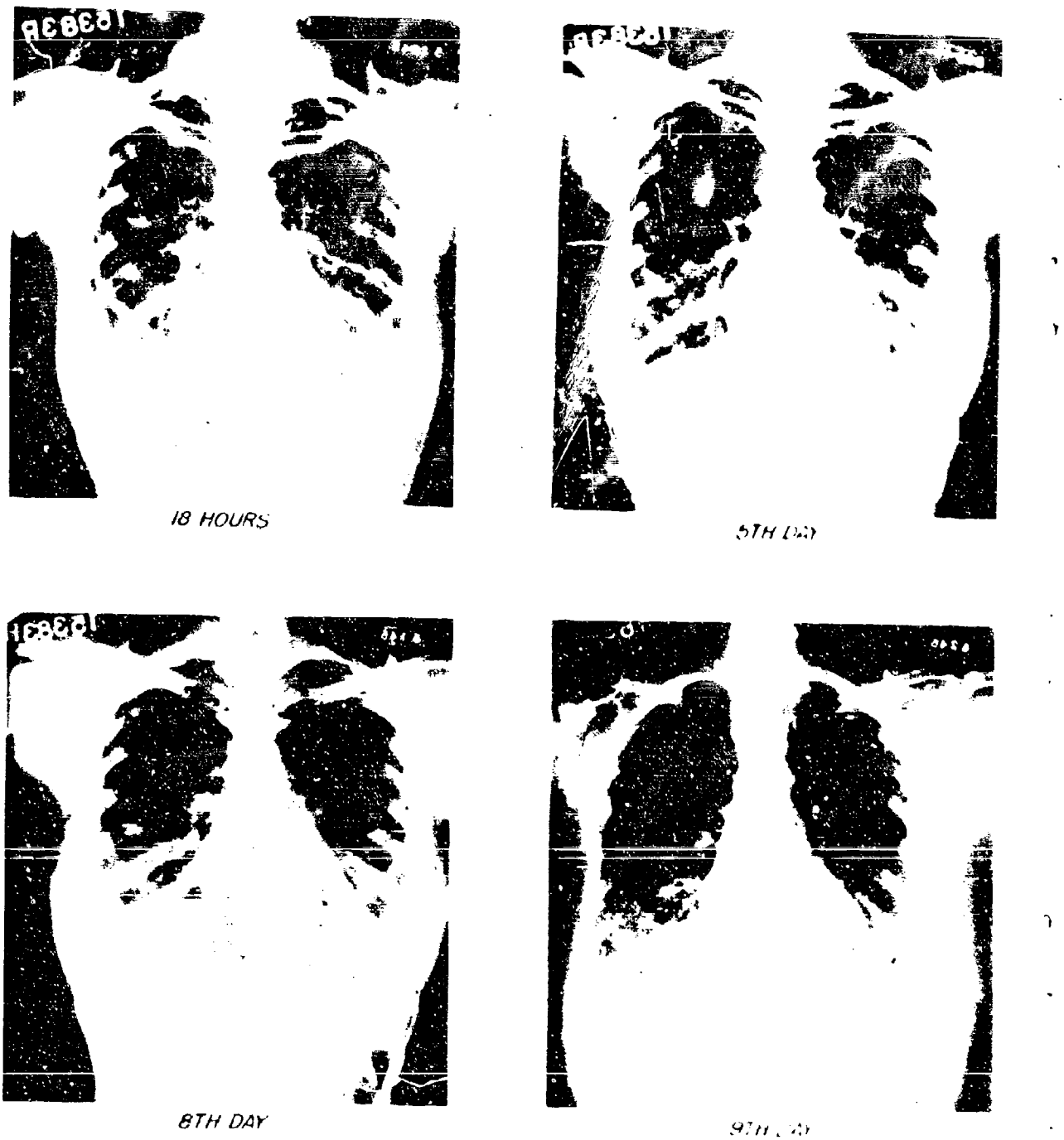
PHOTOGRAPHS AND GRAPHS

1 A

1 B

1 C

Figure 1: - (A) BRONCHIAL CAST dissected open; (B) Photomicrograph (96x) of section of this cast showing its fibrinous character, infiltration of numerous leucocytes, chiefly polymorphonuclear cells. Note single layer of detached, necrotic bronchial epithelium. (C) Photomicrograph (240x) of section of same cast.



18 HOURS

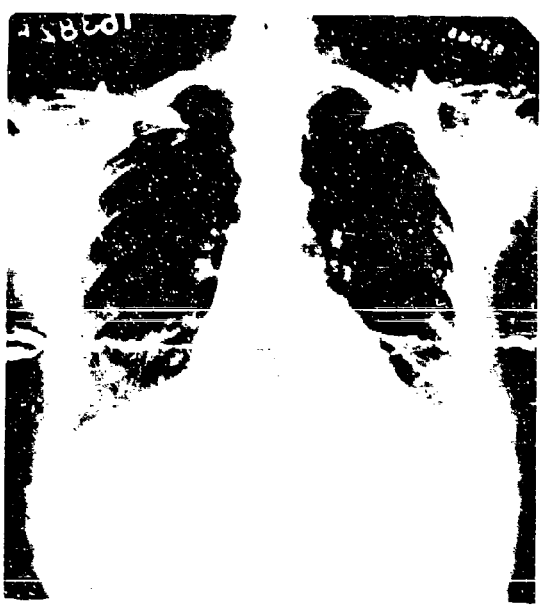
5TH DAY

8TH DAY

9TH DAY

FIG. 2 (CASE I)

18 HOURS



5TH DAY

FIG. 3 (CASE 2)

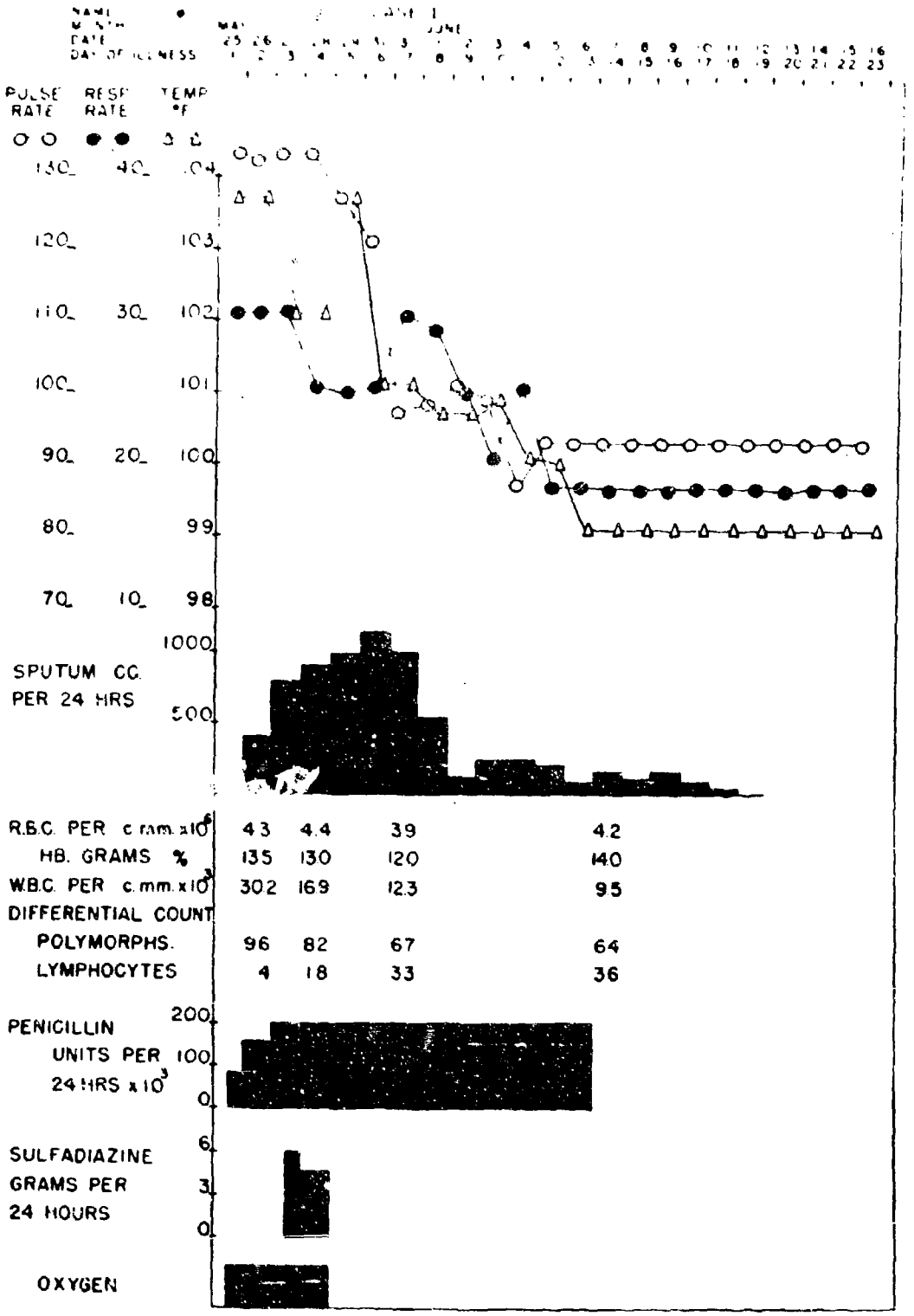

PULSE RATE
RESP RATE
TEMP °F
SPUTUM CC. PER 24 HRS
R.B.C. PER c.mm. x10⁶ 4.3 4.4 3.9 4.2
HB. GRAMS % 135 130 120 140
W.B.C. PER c.mm. x10³ 30.2 16.9 12.3 9.5
DIFFERENTIAL COUNT
POLYMORPHS. 96 82 67 64
LYMPHOCYTES 4 18 33 36
PENICILLIN UNITS PER 24 HRS x10³
SULFADIAZINE GRAMS PER 24 HOURS
OXYGEN

Chart 1

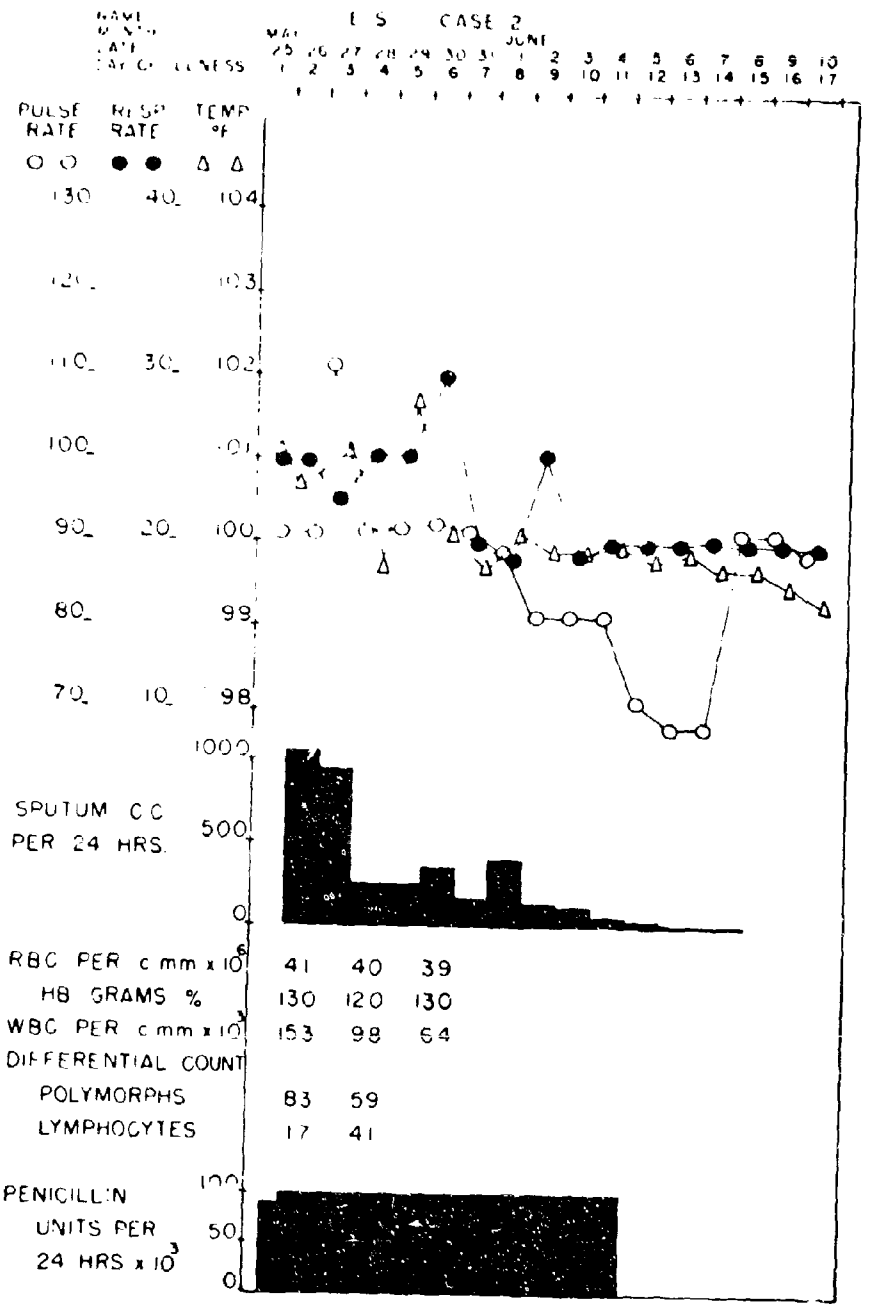

E S CASE 2
MAY
JUNE
PULSE RATE
RESP RATE
TEMP °F
SPUTUM C C PER 24 HRS.
RBC PER c mm x 10⁶
HB GRAMS %
WBC PER c mm x 10³
DIFFERENTIAL COUNT
POLYMORPHS
LYMPHOCYTES
PENICILLIN UNITS PER 24 HRS x 10³
41 40 39
130 120 130
153 98 64
83 59
17 41

Chart 2

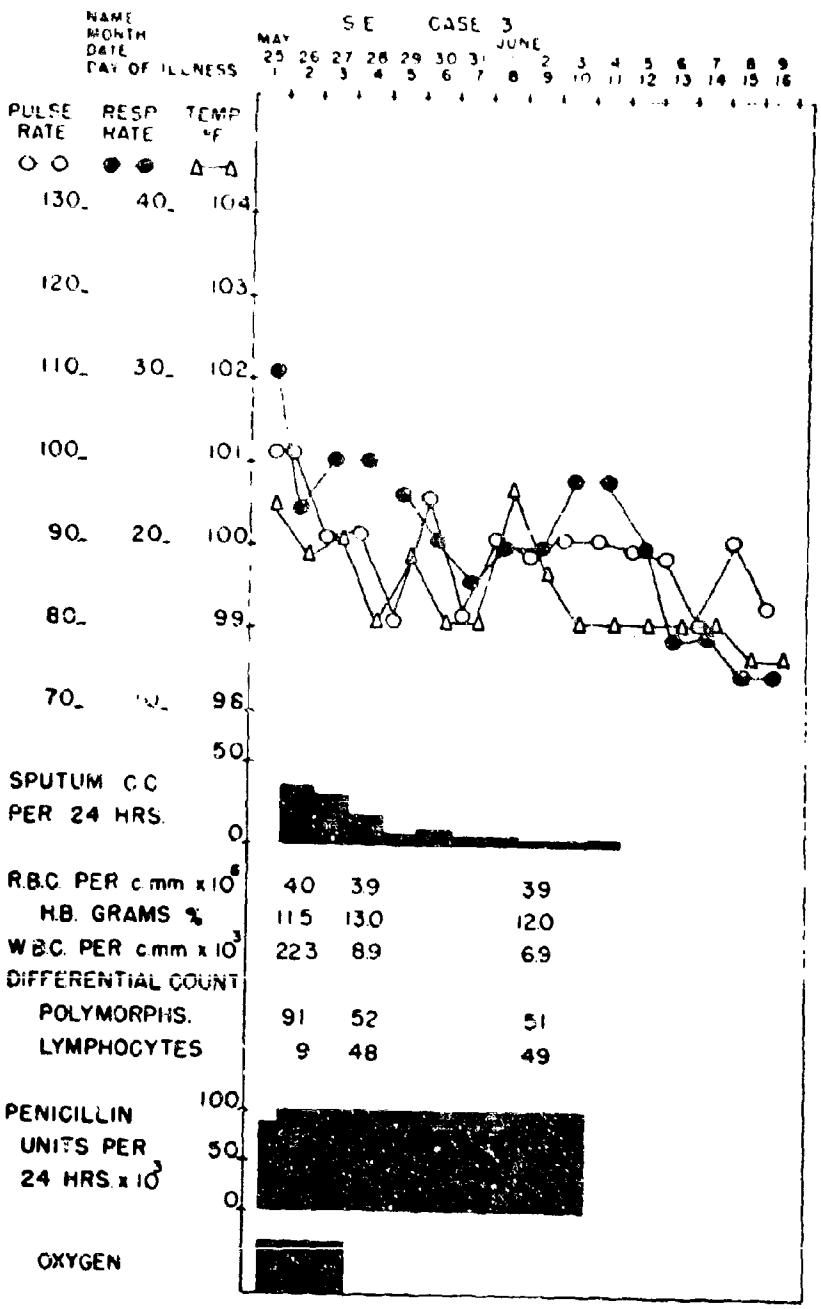

NAME S E CASE 3
MONTH MAY JUNE
DATE 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
DAY OF ILLNESS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
PULSE RATE
RESP RATE
TEMP °F
130 120 110 100 90 80 70
40 30 20
104 103 102 101 100 99 98
SPUTUM C.C PER 24 HRS.
50 0
R.B.C. PER c.mm x 10⁶ 40 39 39
H.B. GRAMS % 115 130 120
W.B.C. PER c.mm x 10³ 223 89 69
DIFFERENTIAL COUNT
POLYMORPHS. 91 52 51
LYMPHOCYTES 9 48 49
PENICILLIN UNITS PER 24 HRS. x 10³
100 50 0
OXYGEN

Chart 3

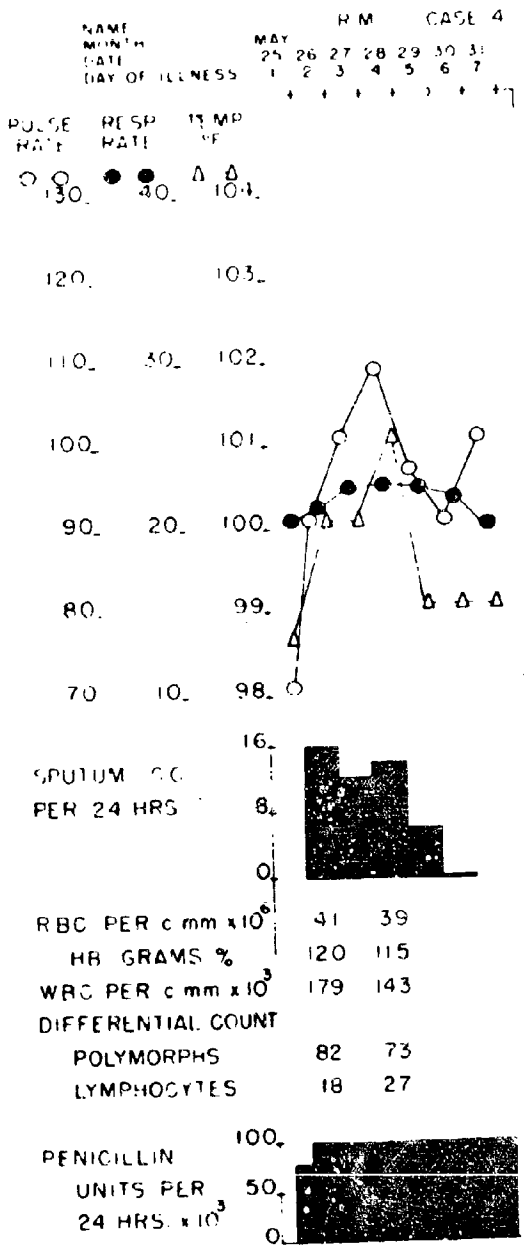

R M CASE 4
NAME
MONTH
DATE
DAY OF ILLNESS
MAY
25 26 27 28 29 30 31
1 2 3 4 5 6 7
PULSE RATE
RESP RATE
TEMP °F
130
40
104
120
110
100
90
80
70
30
20
10
103
102
101
100
99
98
SPUTUM C.C. PER 24 HRS
16
8
0
RBC PER c mm x10⁶ 41 39
HB GRAMS % 120 115
WBC PER c mm x10³ 179 143
DIFFERENTIAL COUNT
POLYMORPHS 82 73
LYMPHOCYTES 18 27
PENICILLIN UNITS PER 24 HRS. x10³
100
50
0

Chart 4

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Medical Division Report No. 103
WP Casualties at Edgewood
Arsenal, Maryland, 1945.

Authority:

Project No. D 8.1
Test Program No. None

Experimental Data:

Date Started: 17 May 1945
Date Completed: 31 December 1945
Notebook Number: None

SUBMITTED BY:

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James Walker, Jr.*
Captain, MC

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Jack Wexler
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UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
Medical Division
Edgewood Arsenal, Maryland

2a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

2b. GROUP
N/A

3. REPORT TITLE

WP Casualties at Edgewood Arsenal, Maryland, 1945 (U)

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
This work was started in May 1945 and completed in December 1945

5. AUTHOR(S) *(First name, middle initial, last name)*

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6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
31 March 1947	141	07

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
N/A	
b. PROJECT NO. D 8.1	MDR 103
c.	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	N/A

10. DISTRIBUTION STATEMENT
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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
Prevention and Treatment of Chemical Casualties	N/A

13. ABSTRACT

(U) This investigation was undertaken to evaluate the white phosphorus (WP) burn in a series of human patients received from WP loading plant accidents at Edgewood Arsenal, Maryland.

14. KEYWORDS

WP casualties	Third degree burns
Absorption	Thermal burns
Temperatures	Inhalation
Concentrations	WP smoke
First aid treatment	Debridement
Hematology	Electrolytes
Blood chemistry	Urine chemistry

DD FORM 1 NOV 68 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED
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Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT

Security Classification